

PHYSICS

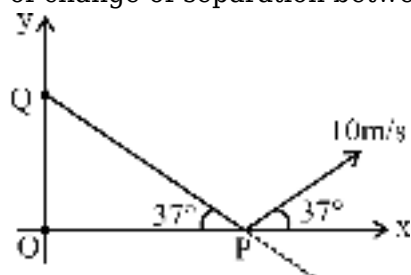
1) Angular frequency ω of surface waves on a lake depends on surface tension T , density of water ρ and wave number $k = \frac{2\pi}{\lambda}$ where λ is wavelength. Group velocity is defined as $v_g = \frac{\partial \omega}{\partial k}$. Expression for group velocity is given by, where C is dimensionless constant of proportionality:

- (1) $v_g = CT^{1/2} \rho^{-1/2} k^{3/2}$
- (2) $v_g = CT^{3/2} \rho^{-1/2} k^{1/2}$
- (3) $v_g = CT^{3/2} \rho^{+1/2} k^{-1/2}$
- (4) $v_g = CT^{1/2} \rho^{-1/2} k^{1/2}$

2) To cross the river in shortest distance, a swimmer should swim making angle θ with the upstream. What is the ratio of the time taken to swim across covering shortest distance to that in swimming across in the shortest time [Assume speed of swimmer in still water is greater than the speed of river flow] :-

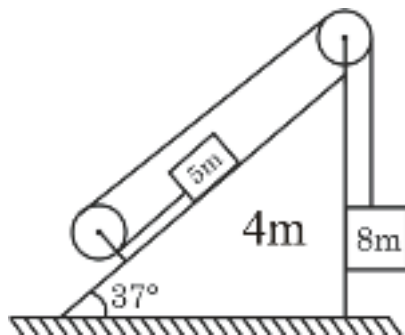
- (1) $\cos \theta$
- (2) $\sin \theta$
- (3) $\tan \theta$
- (4) $\operatorname{cosec} \theta$

3) O is origin and Q is fixed point on y -axis. A point P is moving with constant velocity of 10 m/s as shown. At some moment it is on x -axis. Rate of change of separation between O and P is R_1 and rate of change of separation between Q and P is R_2 . What is $\frac{R_1}{R_2}$ at the moment shown in diagram.



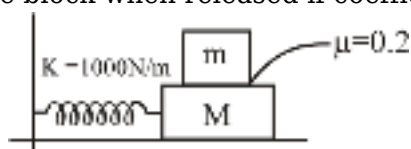
- (1) $\frac{20}{7}$
- (2) 1
- (3) $\frac{4}{3}$
- (4) None of these

4) In the system as shown in figure, all surfaces are smooth, pulley and string are massless. The string between two pulley & between pulley and block of mass $5m$ is parallel to inclined surface. If system is released from rest then acceleration of the wedge is



- (1) $\frac{11g}{13} \text{ m/sec}^2$
- (2) $\frac{440}{205} \text{ m/sec}^2$
- (3) $\frac{5g}{13} \text{ m/sec}^2$
- (4) None of these

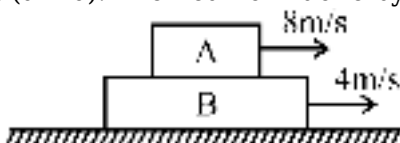
5) A block of mass $M = 4\text{ kg}$ is kept on a smooth horizontal plane. A bar of mass $m = 1\text{ kg}$ is kept on it. They are connected to a spring as shown & the spring is compressed. Then what is the maximum compression in the spring for which the bar will not slip on the block when released if coefficient of



friction between them is 0.2 & spring constant $k = 1000 \text{ N/m}$.

- (1) 1 cm
- (2) 1 m
- (3) 1.25 cm
- (4) 10 cm

6) At an instant $t = 0$, Block A of mass 1 kg is moving with speed 8 m/s towards right on rough surface of block B of mass 3 kg. Block B, which is placed on smooth horizontal surface is moving with speed 4 m/s towards right at same instant ($t = 0$). The net work done by the frictional force in



long time is (block A will not fall from block B)

- (1) -2 J
- (2) -6 J
- (3) -4 J
- (4) -8 J

7) The potential energy function for the two atoms is expressed as $U(r) = a/r^{12} - b/r^6$. The equilibrium distance between them is-

- (1) $(a/b)^{1/6}$
- (2) $(2a/b)^{1/6}$
- (3) $(b/a)^{1/6}$

(4) $(b/2a)^{1/6}$

8) A uniform chain of mass M and length L is lying on a frictionless table in such a way that its $1/3$ part is hanging vertically down. The work done in pulling the chain up the table is

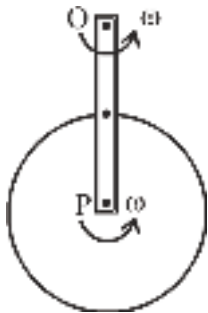
(1) $\frac{MgL}{9}$

(2) $\frac{MgL}{18}$

(3) $\frac{2MgL}{27}$

(4) $\frac{2MgL}{3}$

9) A rod of mass m and length $2R$ can rotate about an axis passing through O in vertical plane. A disc of mass m and radius R is hinged to the other end P of the rod and can freely rotate about P . When disc is at lowest point both rod and disc has angular velocity ω . If rod rotates by maximum angle $\theta = 60^\circ$ with downward vertical, the ω in terms of R and g will be :- (all hinges are smooth)



(1) $\sqrt{\frac{9g}{16R}}$

(2) $\sqrt{\frac{3g}{23R}}$

(3) $\frac{1}{3}\sqrt{\frac{g}{R}}$

(4) None of these

10) A cord is wound round the circumference of wheel of radius r . The axis of the wheel is horizontal and the moment of inertia about it is I . A weight mg is attached to the cord at the end. The weight falls from rest. After falling through a distance ' h ', the square of angular velocity of wheel will be :-

(1) $\frac{2mgh}{I + 2mr^2}$

(2) $\frac{2mgh}{I + mr^2}$

(3) $2gh$

(4) $\frac{2gh}{I + mr^2}$

11) A system consists of two stars of equal masses that revolve in a circular orbit about a centre of mass midway between them. Orbital speed of each star is v & period is T . Find the mass M of each star (G is gravitational constant)

(1) $\frac{2Gv^3}{\pi T}$

(2) $\frac{v^3 T}{\pi G}$

(3) $\frac{v^3 T}{2\pi G}$

(4) $\frac{2Tv^3}{\pi G}$

12) A liquid of density ' ρ ' flows at a rate Q m³/sec through a pipe of diameter ' d '. If the coefficient of viscosity for the liquid is ' η ', the relation for Reynolds number will be :

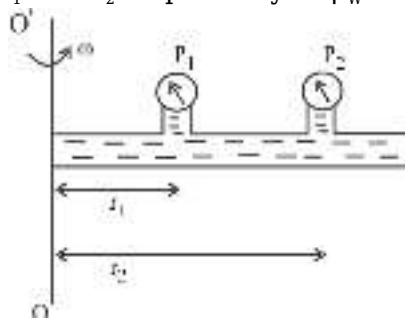
(1) $\frac{4\rho Q}{\pi d \eta}$

(2) $\frac{2\rho Q}{\pi d \eta}$

(3) $\frac{\rho Q}{\pi d \eta}$

(4) $\frac{\rho Q}{\pi d^2 \eta}$

13) A tube filled with water and closed at both ends rotates uniformly in a horizontal plane about the axis OO' . The manometers fixed in the tube wall at distances r_1 and r_2 from the rotational axis indicate pressures P_1 and P_2 respectively. If ρ_w is the density of water then find the angular velocity



of rotation of tube.

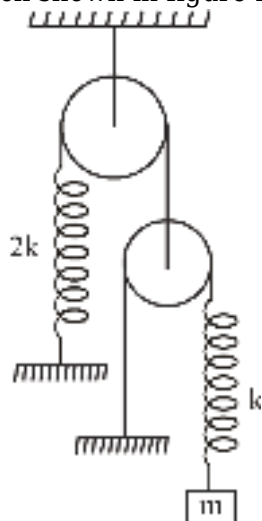
(1) $\sqrt{\frac{2(P_2 - P_1)}{(r_2 - r_1)^2 \rho_w}}$

(2) $\sqrt{\frac{2(P_2 - P_1)}{(r_2^2 - r_1^2) \rho_w}}$

(3) $\sqrt{\frac{(P_2 - P_1)}{(r_2^2 - r_1^2) \rho_w}}$

(4) $\sqrt{\frac{(P_2 - P_1)}{(r_2 - r_1)^2 \rho_w}}$

14) If the block shown in figure is displaced slightly and released, find the time period of oscillations



of the block.

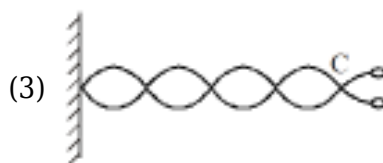
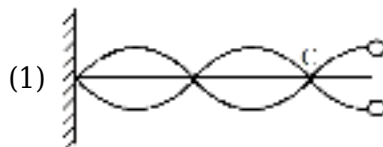
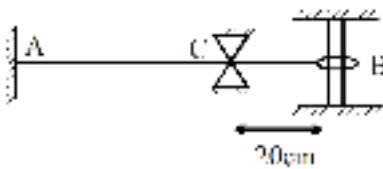
(1) $T = 3\pi\sqrt{\frac{m}{2K}}$

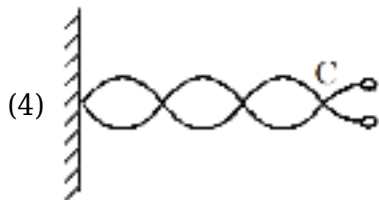
(2) $T = 2\pi\sqrt{\frac{5m}{K}}$

(3) $T = 2\pi\sqrt{\frac{3m}{K}}$

(4) $T = 2\pi\sqrt{\frac{2m}{K}}$

15) A 1m long wire having tension T is fixed at A and free at B. The point C, 20 cm from B is constrained to be stationary. What is shape of string for fundamental mode?





16) A source of frequency n and an observer are moving on a straight line with velocities a and b respectively. If the source is ahead of the observer and if the medium is also moving in the direction of their motion with velocity c (the velocity of sound being v) then the apparent frequency of sound heard by the observer would be :

(1) $\left(\frac{v+c+b}{v+c+a}\right) n$

(2) $\left(\frac{v-c+b}{v-c+a}\right) n$

(3) $\left(\frac{v-c-b}{v-c-a}\right) n$

(4) $\left(\frac{v+c-b}{v+c-a}\right) n$

17) Average distance travelled by a molecule between two successive collision is given by $\frac{1}{\sqrt{2}\pi d^2 n}$ where d is diameter of molecule and n is No. of molecule per unit volume. If gas in a container expands according to the relation $TV^2 = \text{constant}$. Then average time between two collision of gas molecules in container is :-

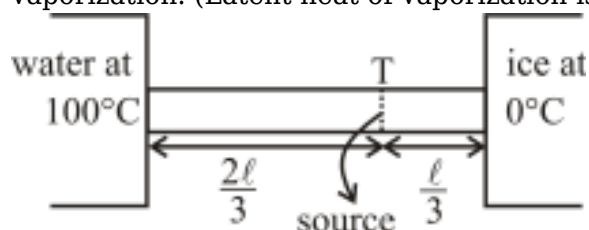
(1) Proportional to temperature

(2) Proportional to volume

(3) Inversely proportional to temperature

(4) Inversely proportional to $(\text{vol})^2$

18) The rod connecting two reservoir and connected to a source is as shown in diagram. The rod is in steady state. Find the temperature of source, so that rate of melting of ice is 16 times that rate of vaporization. (Latent heat of vaporization is 540 Cal/gm and latent heat of fusion is 80 Cal/gm)



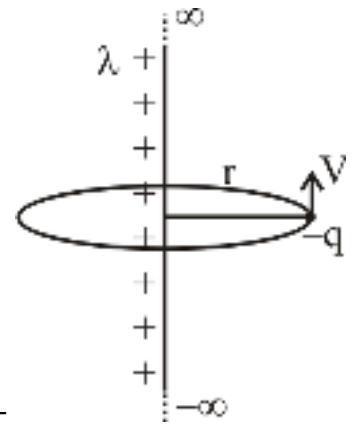
(1) 540° C

(2) 580° C

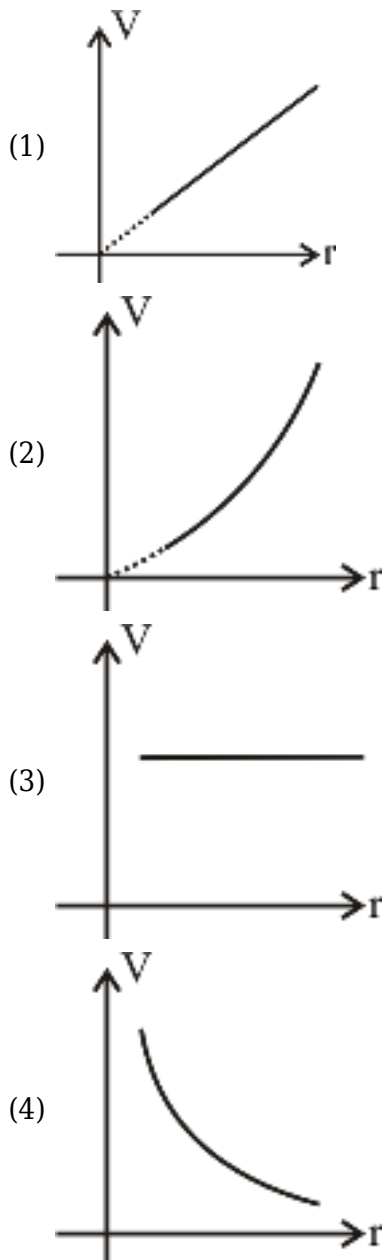
(3) 640° C

(4) 740° C

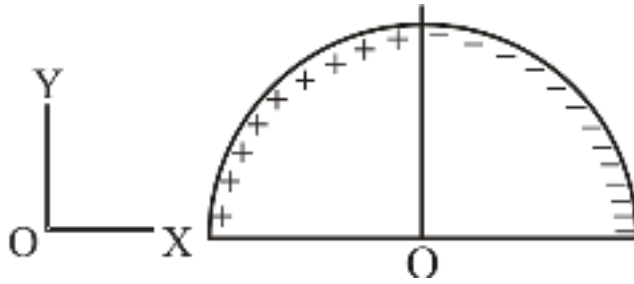
19) A charge $-q$ of mass m is rotating in circle of radius r , around an infinite large uniformly charged



wire as shown. Speed of charge is V then choose the correct option:-



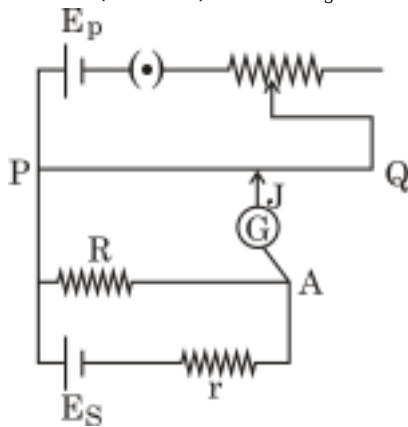
20) A wire, of length L ($= 20 \text{ cm}$), is bent into a semi-circular arc. If the two equal halves, of the arc, were each to be uniformly charged with charges $\pm Q$, $[|Q| = 10^3 \epsilon_0 \text{ Coulomb}]$ where ϵ_0 is the permittivity (in SI units) of free space, the net electric field at the centre O of the semi-circular arc



would be :-

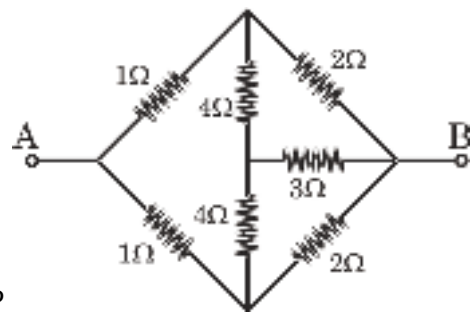
- (1) $(50 \times 10^3 \text{ N/C}) \hat{j}$
- (2) $(50 \times 10^3 \text{ N/C}) \hat{i}$
- (3) $(25 \times 10^3 \text{ N/C}) \hat{i}$
- (4) $(25 \times 10^3 \text{ N/C}) \hat{j}$

21) One of the circuits for the measurement of resistance by potentiometer is shown. The galvanometer is connected at point A and zero deflection is observed at length PJ = 30 cm. In second case the secondary cell is changed and the zero deflection is observed at length PJ = 10 cm. What is the resistance R (in ohm)? Take $E_s = 10 \text{ V}$ & $r = 1 \Omega$ in 1st reading and $E_s = 5 \text{ V}$ & $r = 2 \Omega$ in 2nd



reading :-

- (1) 1Ω
- (2) 2Ω
- (3) 3Ω
- (4) 4Ω

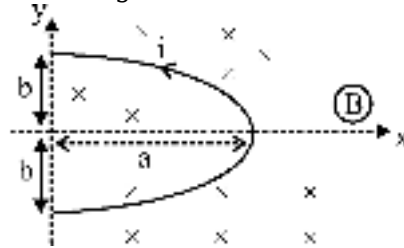


22) What is the equivalent resistance between points A & B ?

- (1) $\frac{5}{6} \Omega$
- (2) $\frac{1}{2} \Omega$

- (3) $\frac{4}{3}\Omega$
 (4) $\frac{7}{6}\Omega$

23) In the figure, there is a conducting wire having current i and which has a shape of half ellipse $\left[\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1 \right]$ is kept in a uniform magnetic field B as shown. If the mass of wire is m , the



acceleration of wire will be :-

- (1) $\frac{ibB}{m}$
 (2) $\frac{iaB}{m}$
 (3) $\frac{2iaB}{m}$
 (4) $\frac{2ibB}{m}$

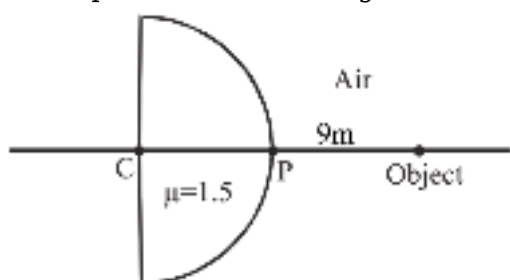
24) A charge $+q$ of mass m is projected in uniform magnetic field $\vec{B} = B_0\hat{i}$ with velocity $\vec{v} = 4\hat{i} + 3\hat{j} - 7\hat{k}$. Pitch of path of particle is P_0 . Now the same charge particle is projected in uniform magnetic field $\vec{B}_2 = 2B_0\hat{i}$ with velocity $\vec{v}_2 = 8\hat{i} + 6\hat{j} - 14\hat{k}$. This time pitch of path is P_2 then :-

- (1) $P_2 = 2P_0$
 (2) $P_2 = 4P_0$
 (3) $P_2 = P_0$
 (4) $P_2 = 8P_0$

25) A charged particle going around in a circle can be considered to be a current loop. A particle of mass m carrying charge q is moving in a plane with speed v under the influence of magnetic field $\vec{B}$. The magnetic moment of this moving particle :

- (1) $-\frac{mv^2\vec{B}}{B^2}$
 (2) $-\frac{mv^2\vec{B}}{2\pi B^2}$
 (3) $\frac{mv^2\vec{B}}{2B^2}$
 (4) $-\frac{mv^2\vec{B}}{2B^2}$

26) A point object is placed at a distance of 9 meter from a glass hemisphere of refractive index $\mu = \frac{3}{2}$ then position of final image from C is (radius of hemisphere is 3 meter) :-



- (1) 15 m right of C
- (2) 16 m left of C
- (3) 22.5 m left of C
- (4) 22.5 m right of C

27) In YDSE, the source placed symmetrically with respect to the slit is now moved parallel to the



plane of the slits it is closer to the upper slit, as shown. Then,

- (1) the fringe width will increase and fringe pattern will shift down.
- (2) the fringe width will remain same but fringe pattern will shift up.
- (3) the fringe width will decrease and fringe pattern will shift down.
- (4) the fringe width will remain same but fringe pattern will shift down.

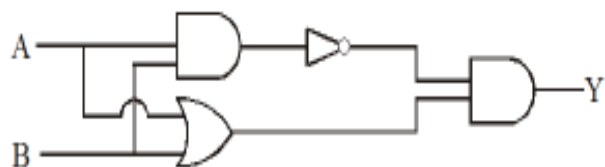
28) In hydrogen atom, electron excites from ground state to higher energy state and its orbital velocity is reduced to $\frac{1}{3}$ rd of its initial value. The radius of the orbit in the ground state is R. The radius of the orbit in that higher energy state is :

- (1) 2 R
- (2) 3 R
- (3) 27 R
- (4) 9 R

29) Half life of a radioactive substance is 20 minute. Difference between points of time when it is 33% disintegrated and 67% disintegrated is approximately

- (1) 40 minute
- (2) 10 minute
- (3) 15 minute
- (4) 20 minute

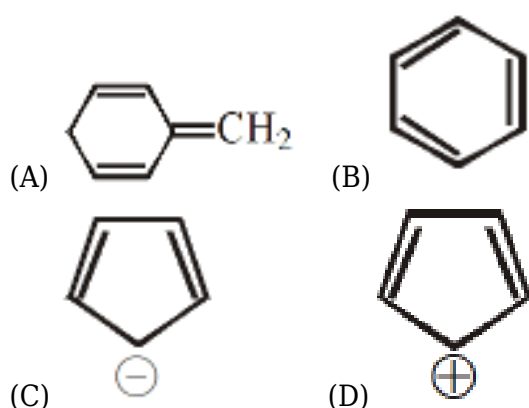
30) Which one of the following will be the output of the given circuit ?



- (1) NOR Gate
- (2) NAND Gate
- (3) AND Gate
- (4) XOR Gate

CHEMISTRY

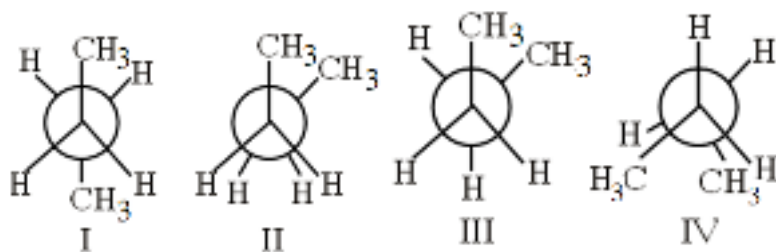
1) Among the following, the aromatic compounds are :



Choose the correct answer from the following options :

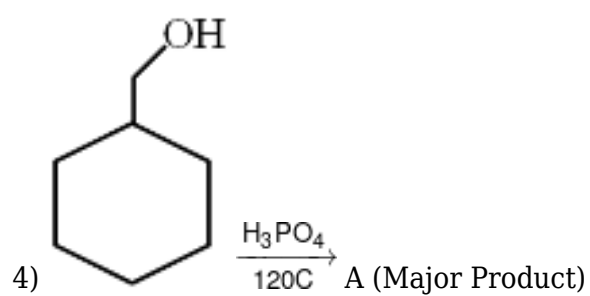
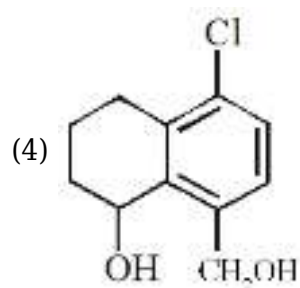
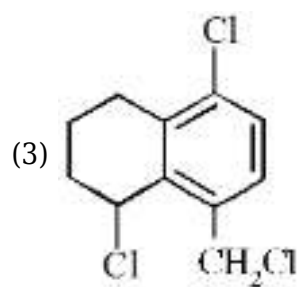
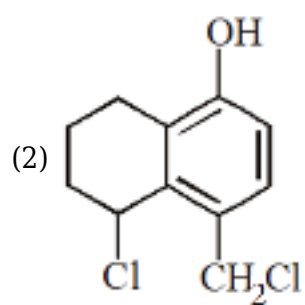
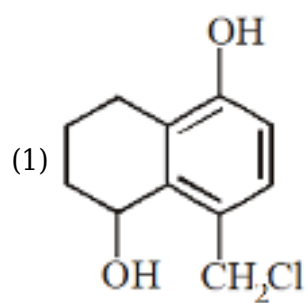
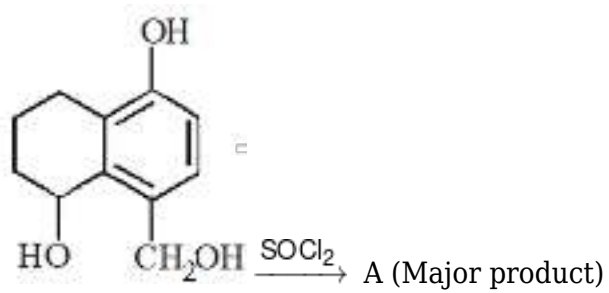
- (1) (A) and (B) only
- (2) (B) and (C) only
- (3) (B), (C) and (D) only
- (4) (A), (B) and (C) only

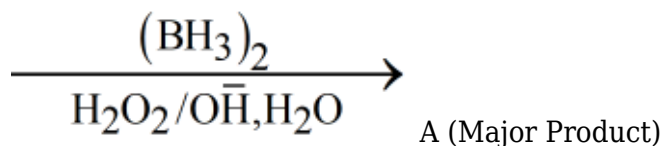
2) Arrange the following conformational isomers of n-butane in order of their increasing potential energy :



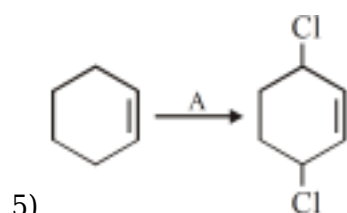
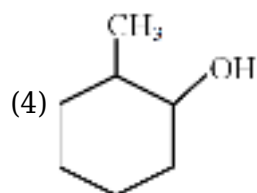
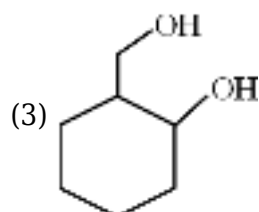
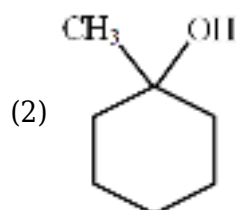
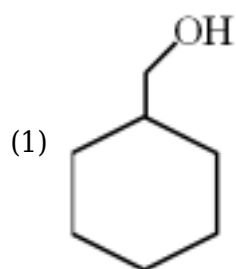
- (1) II < III < IV < I
- (2) I < IV < III < II
- (3) II < IV < III < I
- (4) I < III < IV < II

3) Identify A in the given reaction.





Consider the above reaction and identify the Product P :



Identify the reagent(s) 'A' and condition(s) for the reaction :

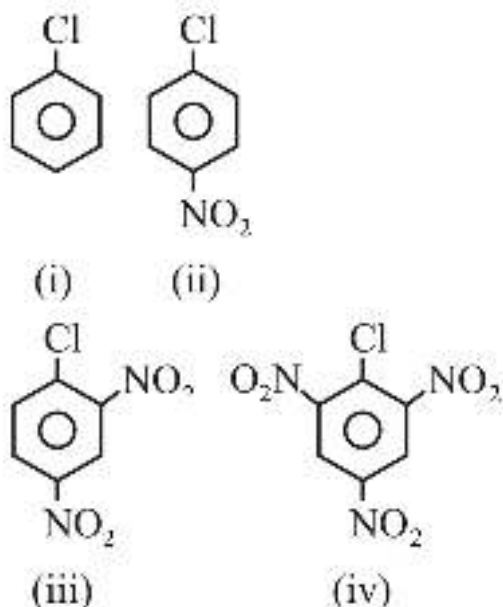
(1) A = HCl; Anhydrous AlCl_3

(2) A = HCl, ZnCl_2

(3) A = Cl_2 ; UV light

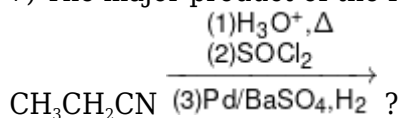
(4) A = Cl_2 ; dark, Anhydrous AlCl_3

6) The correct order of the following compounds showing increasing tendency towards nucleophilic substitution reaction is :-



- (1) (iv) < (iii) < (ii) < (i)
 (2) (iv) < (i) < (ii) < (iii)
 (3) (iv) < (i) < (iii) < (ii)
 (4) (i) < (ii) < (iii) < (iv)

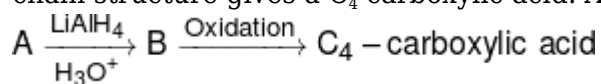
7) The major product of the following chemical reaction is :



- (1) $\text{CH}_3\text{CH}_2\text{CH}_3$
 (2) $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$
 (3) $(\text{CH}_3\text{CH}_2\text{CO})_2\text{O}$
 (4) $\text{CH}_3\text{CH}_2\text{CHO}$

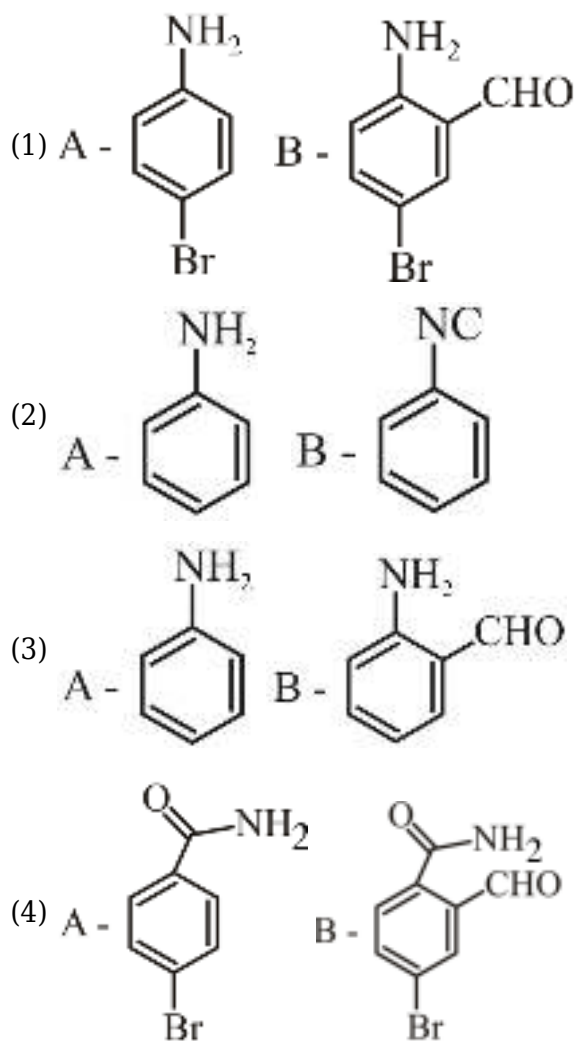
8)

In the following sequence of reactions a compound **A**, (molecular formula $\text{C}_6\text{H}_{12}\text{O}_2$) with a straight chain structure gives a C_4 carboxylic acid. **A** is :



- (1) $\text{CH}_3 - \text{CH}_2 - \text{COO} - \text{CH}_2 - \text{CH}_2 - \text{CH}_3$
 (2) $\text{CH}_3 - \text{CH}_2 - \underset{\text{OH}}{\text{CH}} - \text{CH}_2 - \text{O} - \text{CH} = \text{CH}_2$
 (3) $\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{COO} - \text{CH}_2 - \text{CH}_3$
 (4) $\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{O} - \text{CH} = \text{CH} - \text{CH}_2 - \text{OH}$

9) Hoffmann bromomide degradation of benzamide gives product A, which upon heating with CHCl_3 and NaOH gives product B. The structures of A and B are :



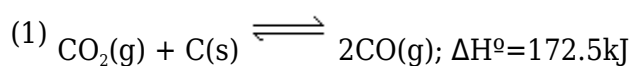
10) Seliwanoff test and Xanthoproteic test are used for the identification of _____ and _____ respectively

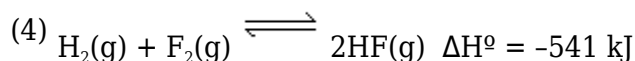
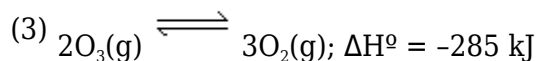
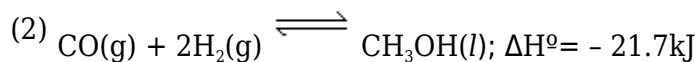
- (1) Aldoses, ketoses
- (2) Proteins, ketoses
- (3) Ketoses, proteins
- (4) Ketoses, aldoses

11) The sodium salt of methyl orange has 7% sodium. What is the minimum molecular weight of the compound?

- (1) 420
- (2) 375
- (3) 329
- (4) 295

12) In which of the following reaction product formation is favoured by decrease in temperature and pressure





13) An atomic solid crystallizes in a body centre cubic lattice and the surface of the atoms at the adjacent corner are separated by 67.0 pm. If the atomic mass of A is 75, then density of the solid is nearly - ($N_A = 6 \times 10^{23}$)

(1) 2.00 gm/cm^3

(2) 1.75 gm/cm^3

(3) 2.5 gm/cm^3

(4) 4.0 gm/cm^3

14) Consider the reaction $\text{A} \rightarrow 2\text{B} + \text{C}$, $\Delta H = -15\text{ kcal}$. The energy of activation of backward reaction is 20 kcal mol^{-1} . In presence of catalyst, the energy of activation of forward reaction is 3 kcal mol^{-1} . At 400K the catalyst causes the rate of the forward reaction to increase by the number of times equal to

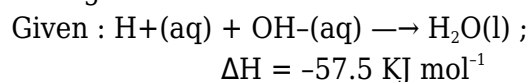
(1) $e^{3.5}$

(2) $e^{2.5}$

(3) $e^{-2.5}$

(4) $e^{2.303}$

15) 0.2 M ; 100 ml NaOH is mixed with 0.4 M ; 100 ml HCl solution. Determine energy released during the reaction.



(1) 1150 J

(2) 1150 KJ

(3) 2300 J

(4) 2300 KJ



The value of K_p for above equilibrium is 64 atm^4 . The equilibrium pressure of the system is

(1) 4 atm

(2) 8 atm

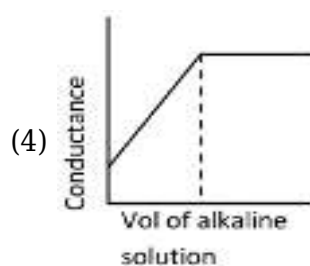
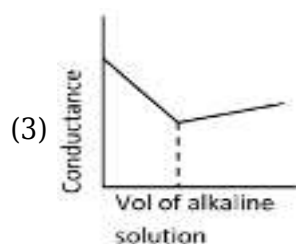
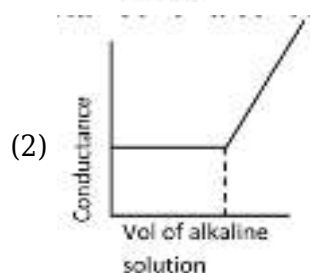
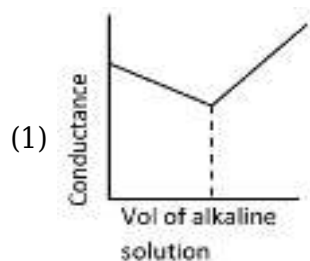
(3) 2 atm

(4) 6 atm

17) The precipitate of CaF_2 ($K_{sp} = 1.7 \times 10^{-10}$) is obtained when equal volumes of the following are mixed

- (1) $10^{-4} \text{ M Ca}^{2+} + 10^{-4} \text{ M F}^{-}$
 (2) $10^{-2} \text{ M Ca}^{2+} + 10^{-3} \text{ M F}^{-}$
 (3) $10^{-5} \text{ M Ca}^{2+} + 10^{-3} \text{ M F}^{-}$
 (4) $10^{-3} \text{ M Ca}^{2+} + 10^{-5} \text{ M F}^{-}$

18) Which of the following plots will be obtained for a conductometric titration of strong acid against a weak base?



19)

The equilibrium $\text{Cu}^{++}(\text{aq}) + \text{Cu}(\text{s}) \rightarrow 2\text{Cu}^{+}$ established at 25°C corresponds to $\frac{[\text{Cu}^{+}]}{[\text{Cu}^{++}]^2} = 2.0 \times 10^4$. The standard potential, $E^{\circ}_{\text{Cu}^{++}/\text{Cu}} = 0.34$ volt. At this temperature, what is the standard potential, $E^{\circ}_{\text{Cu}^{+}/\text{Cu}}$?

- (1) -0.598 V
 (2) -0.125 V
 (3) 0.66 V
 (4) 0.489 V

20) If the binding energy of the electron in a hydrogen atom is 13.6 eV, the energy required to remove the electron from the first excited state of Li^{2+} is :

- (1) 13.6 eV
- (2) 30.6 eV
- (3) 122.4 eV
- (4) 3.4 eV

21) The correct electronic configuration of element having symbol 'Lu' is :

- (1) $[\text{Rn}]5f^{14}6d^{10}7s^2$
- (2) $[\text{Rn}]5f^{14}6d^{10}7s^27p^3$
- (3) $[\text{Rn}]5f^{14}6d^{10}7s^27p^4$
- (4) $[\text{Rn}]5f^{14}6d^{10}7s^27p^1$

22) The correct IUPAC name of potassium permanganate is:

- (1) Potassium tetraoxomanganate(VI)
- (2) Potassium tetraoxidopermanganate(VII)
- (3) Potassium tetraoxidomanganese(VII)
- (4) Potassium tetraoxidomanganate(VII)

23) Which of the following is correct for froth flotation method ?

- (1) Process is applicable for carbonate ore
- (2) Ethyl xanthate act as froth stabilizer
- (3) NaCN act as activator
- (4) Pine oil is frother

24) In the given chemical reaction, colors of the Fe^{2+} and Fe^{3+} ions, are respectively :
 $5\text{Fe}^{2+} + \text{MnO}_4^- + 8\text{H}^+ \rightarrow \text{Mn}^{2+} + 4\text{H}_2\text{O} + 5\text{Fe}^{3+}$

- (1) Yellow, Orange
- (2) Yellow, Green
- (3) Green, Orange
- (4) Green, Yellow

25) Which of the following set of cations would be precipitated by passing H_2S gas in aqueous solution of dilute HCl without undergoing any change in their oxidation state ?

- (1) $\text{Cu}^{2+}, \text{Hg}^{2+}, \text{Fe}^{3+}, \text{Zn}^{2+}$
- (2) $\text{Ag}^+, \text{Pb}^{2+}, \text{Ba}^{2+}, \text{Al}^{3+}$
- (3) $\text{Hg}_2^{2+}, \text{Fe}^{3+}, \text{Mn}^{2+}, \text{Ag}^+$
- (4) $\text{Cu}^{2+}, \text{Hg}^{2+}, \text{Ag}^+, \text{Pb}^{2+}$

26) Which of the following metal halide is least soluble -

- (1) LiF
- (2) NaF
- (3) KF
- (4) RbF

27) When Na and Li are placed in dry air (free from CO_2), what is obtained in considerably large quantity ?

- (1) Na_2O , Li_3N
- (2) Na_2O_2 , Li_3N , Li_2O
- (3) NaN_3 , Li_3N , Li_2O
- (4) Na_2O_2 , Li_2O

28) The pair in which both the ions show PINK color of their aquated ions.

- (1) Mn^{2+} , Fe^{2+}
- (2) Mn^{2+} , Co^{2+}
- (3) Ni^{2+} , Co^{3+}
- (4) Cr^{3+} , Mn^{3+}

29) The correct statement among the following is :-

- (1) $\text{WO}_4^{2-} > \text{MoO}_4^{2-} > \text{CrO}_4^{2-}$ (oxidising power)
- (2) $\text{Ni} > \text{Pt} > \text{Pd}$ (No. of unpaired 'd' electrons)
- (3) $\text{Fe} > \text{Co} > \text{Ni}$ (density)
- (4) $\text{Eu} > \text{Gd} > \text{Tb}$ (No. of protons)

30) H_2O_2 is commercially manufactured by :

- (1) Electrolysis of 50% conc. H_2SO_4
- (2) Electrolysis of molten hydrolith
- (3) Electrolysis of aqueous Na_2O_2
- (4) Electrolysis of molten NaH

ENGLISH PROFICIENCY

1) **Directions :** in each of the following questions, choose the most appropriate alternative to fill in the blanks.

Choose the option that best completes the sentence :

You ____ have misunderstood the instructions; they were explained very clearly.

- (1) may
- (2) should

- (3) can
- (4) must

2) **Directions** : in each of the following questions, choose the most appropriate alternative to fill in the blanks.

Choose the odd one out from the list :

- (1) astonished
- (2) amazed
- (3) stunned
- (4) indifferent

3) **Directions** : in each of the following questions, choose the most appropriate alternative to fill in the blanks.

Select the correct pair of homophones to complete the sentence:

The professor asked the students to ____ the paragraph carefully before submitting their final ____.

- (1) cite / peace
- (2) site / piece
- (3) sight / piece
- (4) cite / piece

4) Select the option that best completes the analogy.

RESILIENT : RECOVER ::

- (1) hesitant : decide
- (2) transparent : hide
- (3) diligent : succeed
- (4) fragile : break

5) Which word carries a **positive** connotation?

- (1) frugal
- (2) stubborn
- (3) nosy
- (4) pushy

6) Choose the academic word that best completes the sentence:

The researcher attempted to _____ the data to identify emerging patterns.

- (1) decorate
- (2) analyze
- (3) imitate
- (4) inflict

7) *In recent years, many cities have attempted to reduce traffic congestion by encouraging the use of public transportation. Although initial responses have been mixed, authorities believe that*

awareness campaigns and improved infrastructure will eventually persuade more commuters to make the shift. This expectation is based on studies showing that people gradually adopt new habits once they recognize long-term benefits such as reduced costs and shorter travel times.

Which idea is the passage MOST LIKELY to discuss next?

- (1) The history of public transport in ancient civilizations
- (2) Examples of cities where public transport failed completely
- (3) Specific strategies that could help increase public transport usage
- (4) A comparison between road construction materials

8) *In recent years, many cities have attempted to reduce traffic congestion by encouraging the use of public transportation. Although initial responses have been mixed, authorities believe that awareness campaigns and improved infrastructure will eventually persuade more commuters to make the shift. This expectation is based on studies showing that people gradually adopt new habits once they recognize long-term benefits such as reduced costs and shorter travel times.*

Which of the following best summarizes the passage?

- (1) Cities have introduced public transport, but commuters reject it due to poor planning.
- (2) Traffic congestion is increasing because people prefer personal vehicles over public transport.
- (3) Authorities expect a gradual rise in public transport use due to awareness efforts and long-term commuter benefits.
- (4) Studies show that commuters travel longer distances when using public transport.

9) *In recent years, many cities have attempted to reduce traffic congestion by encouraging the use of public transportation. Although initial responses have been mixed, authorities believe that awareness campaigns and improved infrastructure will eventually persuade more commuters to make the shift. This expectation is based on studies showing that people gradually adopt new habits once they recognize long-term benefits such as reduced costs and shorter travel times.*

In the passage, the word “**this expectation**” refers to:

- (1) the belief that commuters dislike public transport
- (2) the prediction that more commuters will eventually adopt public transportation
- (3) the idea that traffic congestion will worsen
- (4) the conclusion that awareness campaigns are unnecessary

10) *In recent years, many cities have attempted to reduce traffic congestion by encouraging the use of public transportation. Although initial responses have been mixed, authorities believe that awareness campaigns and improved infrastructure will eventually persuade more commuters to make the shift. This expectation is based on studies showing that people gradually adopt new habits once they recognize long-term benefits such as reduced costs and shorter travel times.*

What does the word “**they**” refer to in the phrase “they recognize long-term benefits” ?

- (1) authorities
- (2) cities
- (3) commuters
- (4) studies

LOGICAL REASONING

1) **Direction :** In each of the following questions, there are two words to the left of the sign :: which are connected in some way. The same relationship obtains between the third word and one of the four alternatives under it. Find the correct alternative in each question.

ACFJ : OUZJ :: SUXB : ?

- (1) GNSA
- (2) GLQZ
- (3) GKPY
- (4) GMRB

2) **Direction :** In each of the following questions, there are two words to the left of the sign :: which are connected in some way. The same relationship obtains between the third word and one of the four alternatives under it. Find the correct alternative in each question.

6 : 24 :: 5 : ?

- (1) 23
- (2) 22
- (3) 26
- (4) 20

3) **Direction :** In each of the following questions, four alternatives are given, out of which three are alike in a certain way while one is different. Choose the odd one.

- (1) 248
- (2) 326
- (3) 414
- (4) 392

4) **Direction :** In each of the following questions, four alternatives are given, out of which three are alike in a certain way while one is different. Choose the odd one.

- (1) Mango
- (2) Apple
- (3) Brinjal
- (4) Grapes

5) Complete the following series :

6.25, 9, 12.25, 16, 20.25, 25, 30.25, ?

- (1) 36
- (2) 32
- (3) 28.25
- (4) 40.25

6) Which sequence of letters when placed at the blanks one after another will complete the given letter series ?

- aba - cabc - dcba - bab - a

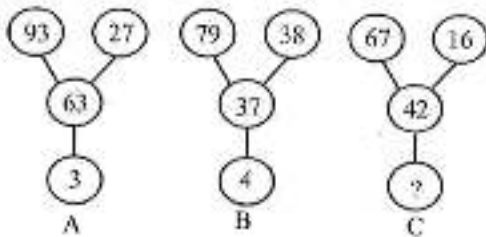
- (1) abdca
- (2) bcadc
- (3) abcdd
- (4) cbdaa

7) **Direction :** In the following question, one term in the number series is wrong. Find out the wrong term

2, 5, 10, 50, 500, 5000

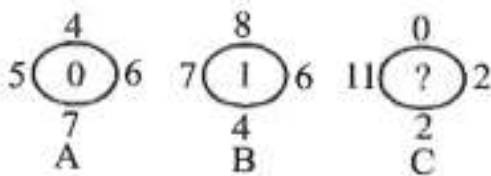
- (1) 5
- (2) 10
- (3) 50
- (4) 5000

8) **Directions :** Find the missing character in each of the following questions.



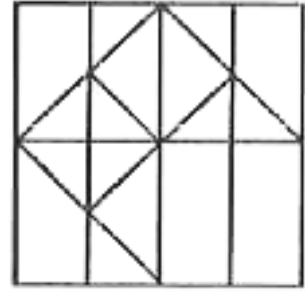
- (1) 5
- (2) 6
- (3) 8
- (4) 9

9) **Directions :** Find the missing character in each of the following questions.

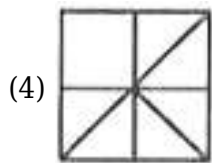
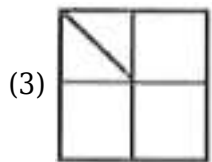
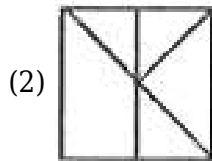
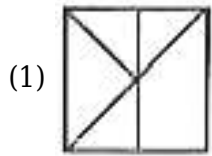


- (1) 0
- (2) 2
- (3) 11
- (4) 12

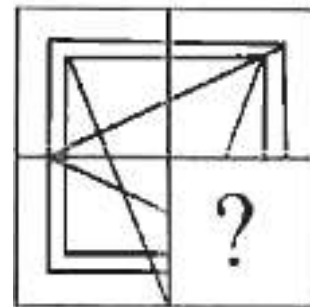
10) **Direction :** In each of the following questions, a part of the figure is missing. Find out from the



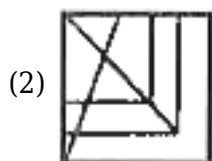
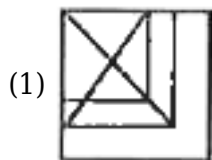
given options (1, 2, 3 and 4) the right figure to fit in the missing place.

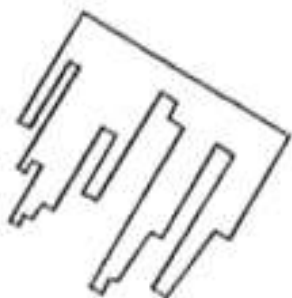
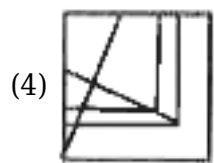
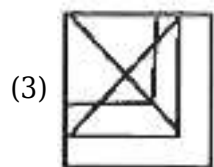


11) **Direction :** In each of the following questions, a part of the figure is missing. Find out from the

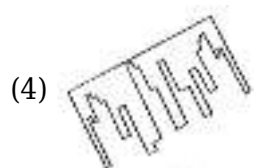
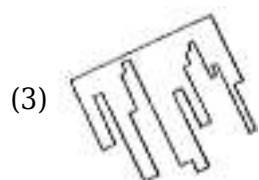
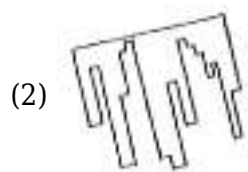
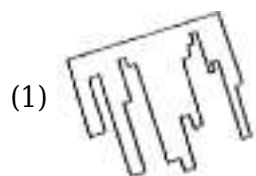


given options (1, 2, 3 and 4) the right figure to fit in the missing place.

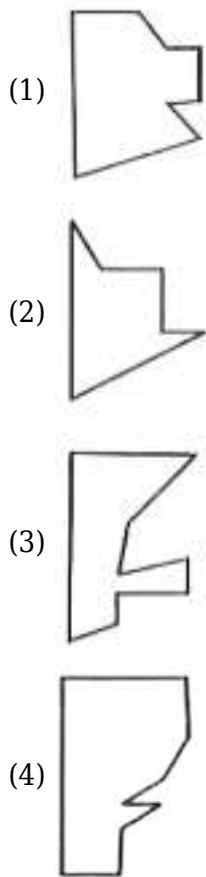




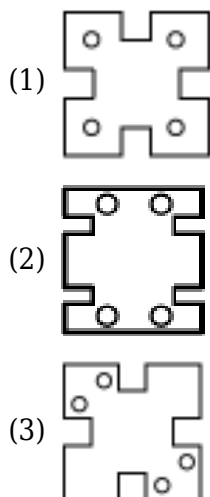
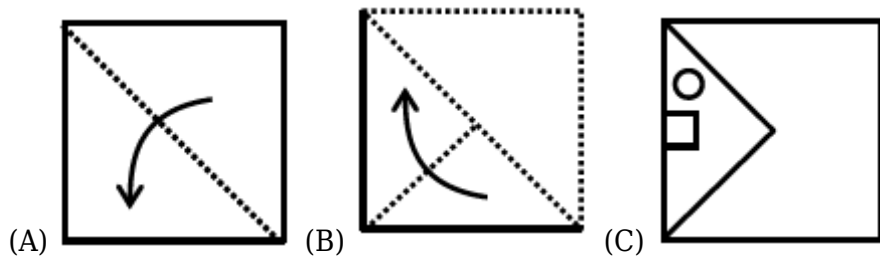
12) (X)

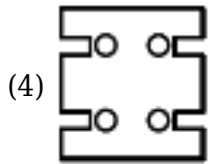


13)

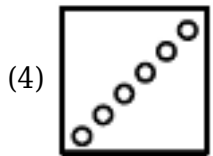
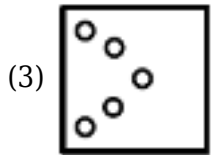
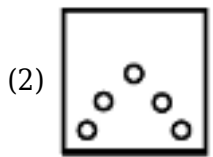
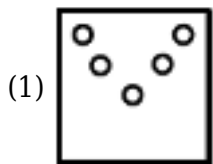
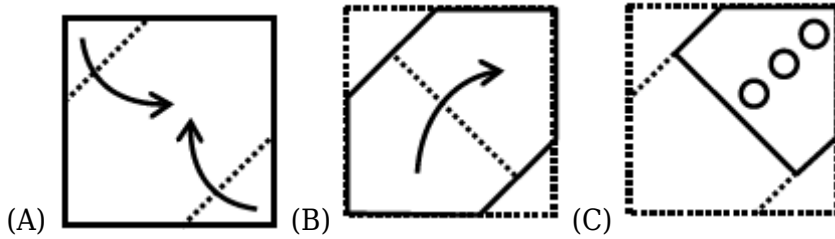


14) **Direction :** In each of the following questions a set of three figures A, B and C showing a sequence of folding of a piece of paper. Fig. (C) shows the manner in which the folded paper has been cut. These three figures are followed by four answer figures from which you have to choose a figure which would most closely resemble the unfolded form of fig, (C).

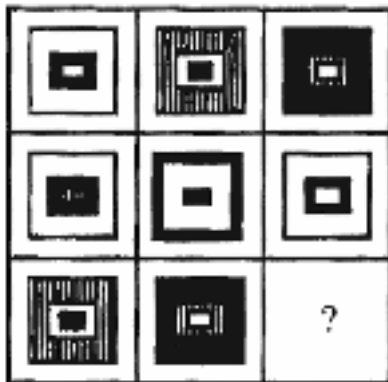




15) **Direction :** In each of the following questions a set of three figures A, B and C showing a sequence of folding of a piece of paper. Fig. (C) shows the manner in which the folded paper has been cut. These three figures are followed by four answer figures from which you have to choose a figure which would most closely resemble the unfolded form of fig, (C).

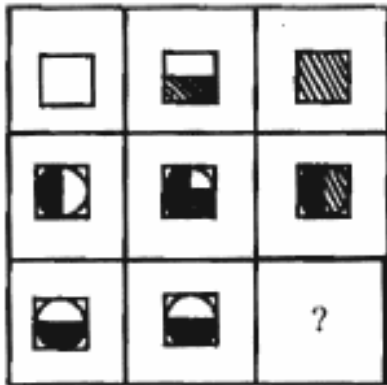


16) **Direction :** In each of the following questions, select the answer figure that will fit in the blank space in the question figure, maintaining the pattern in the proper sequence.



- (1) 
- (2) 
- (3) 
- (4) 

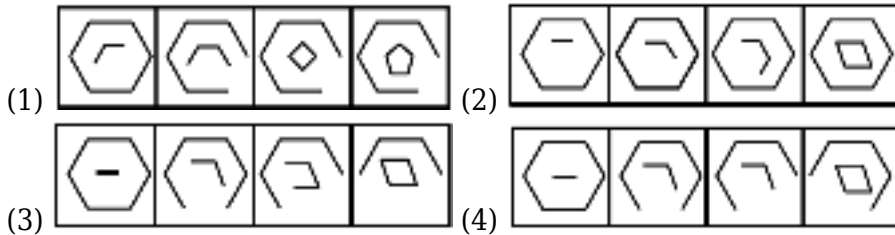
17) **Direction :** In each of the following questions, select the answer figure that will fit in the blank space in the question figure, maintaining the pattern in the proper sequence.



- (1) 
- (2) 
- (3) 
- (4) 

18) Choose the set of figures the given rule.

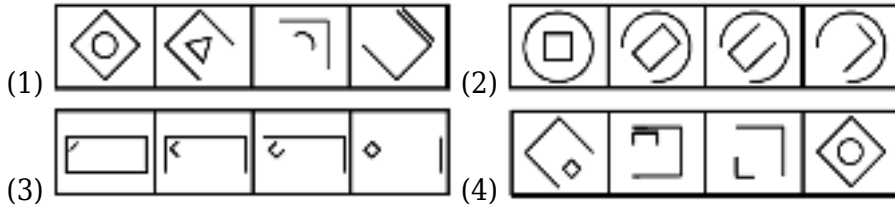
Rule : Closed figures losing their sides and open figures gaining their sides.



- (1) 1
- (2) 2
- (3) 3
- (4) 4

19) Choose the set of figure which follows the given rule.

Rule : Closed figures gradually become open and open figures gradually become closed.



- (1) 1
- (2) 2
- (3) 3
- (4) 4

20) **Direction for Question 20 :** Read the following information carefully and then answer the question given below it :

Following are the criteria for appointing persons for the post of Technical Officer in an organisation. The candidate must :

- (A) be a graduate in Engineering discipline with at least 60% marks.
- (B) Have passed XIIth examination with at least aggregate percentage of 60% in Physics, Chemistry and Mathematics.
- (C) have passed the written examination.
- (D) have passed group discussion and interview with at least 50% marks.
- (E) not be more than 22 years as on 15th July, 1994.

In case of a candidate whose satisfies all other criteria except :

- (I) A above, in terms of percentage of marks but has secured 90% marks in graduation, may be appointed.
- (II) C above, but is a post-graduate in Engineering is to be referred to the Direction-Personnel.
- (III) A above, but has appeared in the final degree examination, may be provisionally appointed.

Based on the above criteria and information provided below, decide the course of action in each a case. You are not to assume anything. if the data provided is not adequate to decide the given course of action, your answer will be 'data inadequate'. These case are given to your as on 1st June, 1994. Sandip Malhotra has appeared in final degree examination in Mechanical Engineering. He has secured 70% aggregate marks in Physics, Chemistry and Mathematics in XIIth Std. He has passed the written examination and interview. He was born on 15th April, 1972.

- (1) Do not appoint
- (2) refer to Director-Personnel
- (3) Appoint provisionally
- (4) Appoint

MATHEMATICS

1) If $\frac{z - \alpha}{z + \alpha}$ ($\alpha \in \mathbb{R}$) is a purely imaginary number and $|z| = 2$, then value of α is :

- (1) 1
- (2) 2
- (3) $\sqrt{2}$
- (4) $\frac{1}{2}$

2) The value of $\left(\frac{-1 + i\sqrt{3}}{1 - i} \right)^{30}$ is :

- (1) $2^{15} i$
- (2) $- 2^{15}$
- (3) $- 2^{15} i$
- (4) 6^5

3) If α and β are the roots of equation $x^2 - 5x - 3 = 0$ and $A_n = \alpha^n + \beta^n$, also $A_{n+2} + \mu A_{n+1} + \nu A_n = 0$, ($n \in \mathbb{N}$) then $(\mu + \nu)$ is equal to-

- (1) 0
- (2) 1
- (3) 8
- (4) -8

4) If the equations $2x^2 + bx + 1 = 0$, $bx^2 + x - 1 = 0$ have a common root, then the value of $b^3 - 6b$ is

- (1) 0
- (2) 2
- (3) 4
- (4) 6

5) If between two positive numbers a & b two A.M.'s A_1, A_2 & two G.M.'s G_1, G_2 are inserted, then

$\frac{G_1^3 + G_2^3}{G_1 G_2}$ is -

- (1) $2(A_1 + A_2)$

(2) $2A_1 + A_2$

(3) $\frac{A_1 + A_2}{2}$

(4) $A_1 + A_2$

6) A number has four divisors and sum of its divisors excluding 1 & itself is 30, then number of such numbers is -

(1) 2

(2) 3

(3) 4

(4) 5

7) The number of four digit numbers that can be made with the digits 1,2,3,4 and 5 in which at least two digits are identical is :-

(1) $4^5 - 5!$

(2) 505

(3) 600

(4) 24

8) The two successive terms in the expansion of $(1 + x)^{24}$ whose coefficients are in the ratio 1 :4 are

(1) 3rd and 4th

(2) 4th and 5th

(3) 5th and 6th

(4) 6th and 7th

9) A square matrix M of order 3 satisfies $M^2 = I - M$, where I is an identity matrix of order 3. If $M^n = 2I - 3M$, then n is equal to -

(1) 4

(2) 5

(3) 6

(4) 7

10) Number of solutions of the equation $\begin{vmatrix} 0 & 2\sin x - 1 & \sin x + 2 \\ 2\sin x - 1 & 0 & \sin x - 3 \\ \sin x - 2 & \sin x - 3 & 0 \end{vmatrix} = 0$ in $(-\pi, \pi)$ is -

(1) 2

(2) 4

(3) 5

(4) 6

11) If $\begin{vmatrix} \sin 2x & \cos^2 x & \cos 4x \\ \cos^2 x & \cos 2x & \sin^2 x \\ \cos^4 x & \sin^2 x & \sin 2x \end{vmatrix} = a + a_1 (\sin x) + a_2 (\sin^2 x) + \dots + a_n (\sin^n x)$ then the value of a is -

- (1) -1
- (2) 1
- (3) 0
- (4) 2

12) In the set $A = \{1, 2, 3, 4, 5\}$ a relation R is defined by $R = \{(x, y) | x, y \in A \text{ and } x < y\}$. Then R is

- (1) Reflexive
- (2) Symmetric
- (3) Transitive
- (4) Equivalence relation

13) Which of the following is correct for the statements p and q is true ?

- (1) $p \wedge q$ is true when at least one from p and q is true
- (2) $p \rightarrow q$ is true when p is true and q is false
- (3) $p \leftrightarrow q$ is true only when both p and q are false
- (4) $\sim(p \vee q)$ is true only when both p and q are false

14) $\tan 10^\circ + 2\tan 20^\circ + 4\tan 40^\circ$ is equal to-

- (1) $\cot 10^\circ + 8\cot 80^\circ$
- (2) $8 \cot 10^\circ - \cot 80^\circ$
- (3) $\tan 80^\circ - 8\tan 10^\circ$
- (4) $8[\tan 80^\circ - \cot 80^\circ]$

15) The number of integral values of ' k ' for which the equation $4 \sin \left(\theta + \frac{\pi}{3} \right) \cos \left(\theta - \frac{\pi}{6} \right) = k^2 + \sqrt{3}$ has a solution, is

- (1) 2
- (2) 3
- (3) 4
- (4) 5

16) $\sin^{-1} \sin 12 + \cos^{-1} \cos 25 + \tan^{-1} \tan 50 + \cot^{-1} \cot 35$ is equal to -

- (1) $20\pi - 22$
- (2) $72 - 23\pi$
- (3) $122 - 39\pi$

(4) $48 - 15\pi$

17) The length of the latus rectum of the parabola $2\{(x - 1)^2 + (y - 3)^2\} = (x + y - 1)^2$ is:-

- (1) 6
- (2) 3
- (3) $6\sqrt{2}$
- (4) $3\sqrt{2}$

18) The curve represented by $x = 3(\cos t + \sin t)$, $y = 4(\cos t - \sin t)$, is :

- (1) ellipse
- (2) parabola
- (3) hyperbola
- (4) circle

19) If distance between the directrices be thrice the distance between the foci, then eccentricity of ellipse is -

- (1) $\frac{1}{2}$
- (2) $\frac{2}{3}$
- (3) $\frac{1}{\sqrt{3}}$
- (4) $\frac{4}{5}$

20) If a be the radius of a circle which touches x -axis at the origin, then its equation is -

- (1) $x^2 + y^2 + ax = 0$
- (2) $x^2 + y^2 \pm 2ya = 0$
- (3) $x^2 + y^2 \pm 2xa = 0$
- (4) $x^2 + y^2 + ya = 0$

21) An equation of a line through the point $A(1, 2)$ whose distance from the point $B(3, 1)$ has the greatest value is

- (1) $y = 2x$
- (2) $y = 2x + 1$
- (3) $x + 2y = 5$
- (4) $y = 3x - 1$

22) If the straight lines $\frac{x-1}{k} = \frac{y-2}{2} = \frac{z-3}{3}$ and $\frac{x-2}{3} = \frac{y-3}{k} = \frac{z-1}{2}$ intersect at a point, then the integer k is equal to-

- (1) -5
- (2) 5
- (3) 2
- (4) -2

23) The line passing through the points (5, 1, a) and (3, b, 1) crosses the yz-plane at the $\left(0, \frac{17}{2}, \frac{-13}{2}\right)$ point . Then-

- (1) a = 2, b = 8
- (2) a = 4, b = 6
- (3) a = 6, b = 4
- (4) a = 8, b = 2

24) Let the line $\frac{x-2}{3} = \frac{y-1}{-5} = \frac{z+2}{2}$ lie in the plane $x + 3y - az + b = 0$. Then (a, b) equals :

- (1) (5, -15)
- (2) (-5, 5)
- (3) (6, -17)
- (4) (-6, 7)

25) Let $\vec{a}, \vec{b}, \vec{c}$ be three non-zero vectors which are pairwise non-collinear. If $\vec{a} + 4\vec{b}$ is collinear with $\vec{c}$ and $3\vec{b} + 2\vec{c}$ is collinear with $\vec{a}$, then $3\vec{a} + 12\vec{b}$ is :

- (1) $-8\vec{c}$
- (2) $-5\vec{c}$
- (3) $5\vec{c}$
- (4) $10\vec{c}$

26) The scalar product $\vec{a} \cdot \{(\vec{b} + \vec{c}) \times (\vec{a} + \vec{b} + \vec{c})\}$ is equal to :-

- (1) 0
- (2) $[\vec{a} \vec{b} \vec{c}]$
- (3) $[\vec{a} \vec{b} \vec{c}] + [\vec{b} \vec{c} \vec{a}]$
- (4) $3 [\vec{a} \vec{b} \vec{c}]$

27) If the mean and variance of six observations 7, 10, 11, 15, a, b are 10 and $\frac{20}{3}$, respectively, then the value of $|\vec{a} - \vec{b}|$ is equal to :

- (1) 9
- (2) 11
- (3) 7

(4) 1

28) A drunkard removes two randomly chosen letters of the message HAPPY HOUR that is attached on a sign board. His drunkard friend put those two letters back in a random order. Then the probability that HAPPY HOUR appears again is equal to

(1) $\frac{17}{36}$

(2) $\frac{18}{36}$

(3) $\frac{19}{36}$

(4) $\frac{25}{46}$

29) If a curve passes through a point (1, 0) and has slope $\left(1 + \frac{1}{x^2}\right)$ at any point (x, y) on it, then the ordinate of the point whose abscissa is -3, is

(1) $\frac{8}{3}$

(2) $\frac{3}{8}$

(3) $-\frac{3}{8}$

(4) $-\frac{8}{3}$

30) $\int \frac{\ln(ex^x)}{xe^x(\ln x)^2} dx$ is-

(where C is constant of integration)

(1) $\frac{1}{e^x \ln x} + C$

(2) $\frac{e^x}{\ln x} + C$

(3) $-\frac{1}{e^x \ln x} + C$

(4) $-\frac{1}{e^{-x} \ln x} + C$

31)

If $\int \frac{dx}{x^2(x^{2015} + 1)^{\frac{2014}{2015}}} = -\left(1 + x^{-b}\right)^{1/a} + C$, then the value of $\frac{a}{b}$ is-

(1) -1

(2) 1

(3) $\frac{2014}{2015}$

(4) $\frac{2016}{2015}$

32)

The value of $\int_0^2 \frac{x^4 + 1}{(x^4 + 2)^{\frac{3}{4}}} dx$ is equal to

(1) $\sqrt{3\sqrt{3}}$

(2) $\sqrt{2\sqrt{2}}$

(3) $\sqrt{3\sqrt{2}}$

(4) $\sqrt{2\sqrt{3}}$

33)

$$\int_{\frac{1}{3}}^{\frac{1000}{3}} (\{x\} + \{-x\}) dx$$

The value of $\frac{1}{3}$ is -
(where $\{.\}$ represents fractional part function)

(1) $\frac{1001}{3}$

(2) 333

(3) 0

(4) $\frac{2002}{3}$

34) Area bounded by $y = \{x\}^{[x]} + [x]$, x-axis between $x = 0$ and $x = 3$ (where $[.]$ denotes greatest integer function and $\{.\}$ denotes fractional part function) is

(1) 3

(2) $\frac{9}{2}$

(3) $\frac{29}{6}$

(4) $\frac{25}{6}$

35) The value of $\lim_{x \rightarrow 0} \left(\cos^4 \left(\frac{x}{2} \right) - \sin^4 \left(\frac{x}{2} \right) \right)^{(\cot x)(\operatorname{cosec} x)}$ is-

(1) $e^{\frac{1}{2}}$

(2) e^2

(3) e^{-1}

(4) $e^{-\frac{1}{2}}$

36) Let $f(x) = \begin{cases} ax + bx^2 & ; \quad x < 1 \\ 4ax - 2b + 1 & ; \quad x \geq 1 \end{cases}$ be continuous and differentiable everywhere, then a & b are -

(1) $\frac{1}{3}, -1$

(2) $\frac{2}{3}, 1$

(3) $\frac{3}{2}, 1$

(4) $\frac{4}{3}, -1$

37) Given $f(x) = \frac{x^2 - 3x - 18}{x^2 - 4x - 12}$, then sum of all real numbers which are not in the range of $f(x)$ is equal to -

(1) $\frac{17}{8}$

(2) 1

(3) -1

(4) $\frac{15}{8}$

38) $\int_0^{\infty} f\left(x + \frac{1}{x}\right) \cdot \frac{\ln x}{x} dx$

(1) is equal to zero

(2) is equal to one

(3) is equal to

$\frac{1}{2}$

(4) can not be evaluated

39) The order of differential equation whose general solution is

$$y = c_1 \cos 2x + c_2 \sin^2 x + c_3 \cos^2 x + c_4 e^{2x} + c_5 e^{2x+c_6}$$

(1) 3

(2) 4

(3) 5

(4) 6

40) If $\vec{a} = 2\hat{i} + \hat{j} - \hat{k}$, $\vec{b} = \hat{i} + \hat{j} + \hat{k}$, $\vec{c}$ is a unit vector which is coplanar with $\vec{a}$ and $\vec{b}$ and perpendicular to $\vec{a}$ and makes an acute angle with z-axis then $\vec{c}$ equals

$$(1) \frac{1}{\sqrt{21}} (\hat{i} - 2\hat{j} + 4\hat{k})$$

$$(2) \frac{1}{\sqrt{21}} (\hat{i} + 2\hat{j} + 4\hat{k})$$

$$(3) \frac{1}{\sqrt{21}} (\hat{i} + 2\hat{j} - 4\hat{k})$$

$$(4) \frac{1}{\sqrt{21}} (-\hat{i} + 2\hat{j} + 4\hat{k})$$

ANSWER KEYS

PHYSICS

Q.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A.	4	4	1	4	1	2	2	2	1	2	4	1	2	3	1	2	3	3	3	3
Q.	21	22	23	24	25	26	27	28	29	30										
A.	1	3	4	3	4	2	4	4	4	4										

CHEMISTRY

Q.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
A.	2	4	2	4	3	4	4	3	2	3	3	3	1	2	1	2	2	3	4	2
Q.	51	52	53	54	55	56	57	58	59	60										
A.	4	4	4	4	4	1	2	2	2	1										

ENGLISH PROFICIENCY

Q.	61	62	63	64	65	66	67	68	69	70
A.	4	4	4	3	1	2	3	3	2	3

LOGICAL REASONING

Q.	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
A.	4	4	4	3	1	1	4	4	3	1	4	3	2	3	4	3	3	3	3	1

MATHEMATICS

Q.	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110
A.	2	3	4	4	4	3	2	3	1	1	1	3	4	3	4	2	4	1	3	2
Q.	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130
A.	1	1	3	4	1	1	4	3	4	3	2	3	2	3	4	2	1	1	1	2

SOLUTIONS

PHYSICS

$$L^1 T^{-1} \propto \left[\frac{M^1 L^1 t^{-2}}{L^1} \right]^a [M^1 L^{-3}]^b [L^{-1}]^c$$

1)

$$a + b = 0 \quad \dots(i)$$

$$+1 = -3b - C \quad \dots(ii)$$

$$-1 = -2a$$

$$a = \frac{1}{2}; \quad b = -\frac{1}{2}$$

$$+1 = -3 \times -\frac{1}{2} - C$$

$$+1 - \frac{3}{2} = -C$$

$$-\frac{1}{2} = -C$$

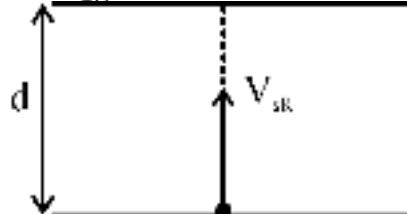
$$C = \frac{1}{2}$$

$$v_g \propto T^{1/2} \rho^{-1/2} k^{1/2}$$

2)

Shortest time

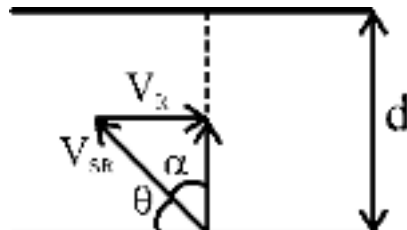
$$t = \frac{d}{V_{SR}}$$



For shortest distance

$$\square V_{SR} > V_R$$

$$\sin \alpha = \frac{V_R}{V_{SR}}$$



time to cross the river t'

$$= \frac{d}{V_{SR} \cos \alpha} = \frac{d}{V_{SR} \sin \theta}$$

$$\text{So, } t'/t = \csc \theta$$

3)

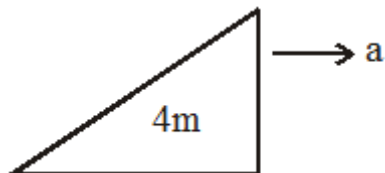
$$R_1 = 10 \cos 37$$

$$R_1 = 10 \cos 2 \times 37$$

$$\frac{R_1}{R_2} = \frac{\cos 37}{\frac{2 \cos^2 37 - 1}{4/5}}$$

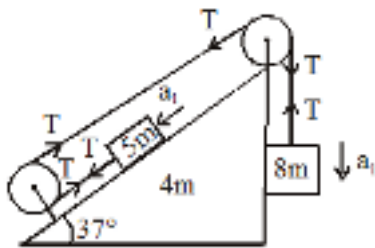
$$= \frac{2 \times \frac{16}{25} - 1}{4/5}$$

$$= \frac{4 \times 25}{5 \times 7} = \frac{20}{7}$$



4)

Then in reference frame of wedge, there would be a pseudo force in direction opposite to a .

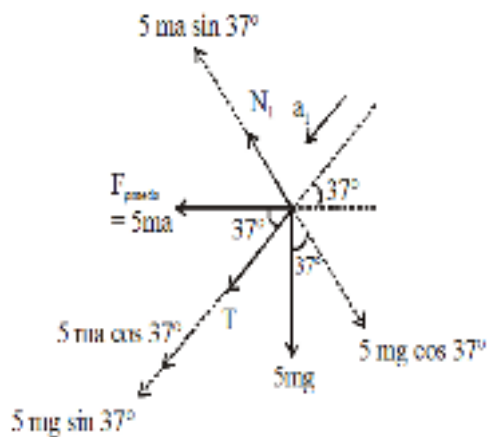


In reference frame of wedge, wedge will be at rest.

□ Work done by tension = 0

$$\square \sum \vec{a} \cdot \vec{T} = 0$$

So acceleration of both blocks would be a_1



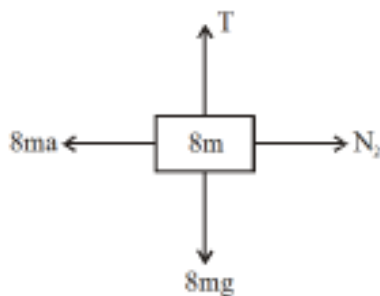
for block (5m)

$$N_1 = 5mg \cos 37^\circ - 5ma \sin 37^\circ$$

$$= 4mg - 3ma \dots\dots(1)$$

$$T + 5mg \sin 37^\circ + 5ma \cos 37^\circ = 5ma_1$$

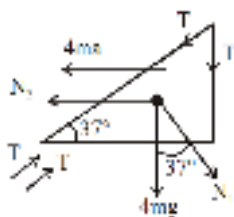
$$T + 3mg + 4ma = 5ma_1 \dots\dots(2)$$



↓ a_1

$$N_2 = 8ma \dots\dots(3)$$

$$8mg - T = 8ma_1 \dots\dots(4)$$



In horizontal direction

$$N_2 + 4ma - \frac{4T}{5} = N_1 \sin 37^\circ$$

$$\square N_2 = 8ma \text{ [From Eqn (3)]}$$

$$\therefore 12ma - \frac{4T}{5} = \frac{3}{5}N_1 \dots\dots(5)$$

$$\text{eq}^n (2) + \text{eq}^n (4)$$

$$11mg + 4ma = 13ma_1 \dots\dots(6)$$

from eqⁿ (4) and (6)

$$T = 8mg - 8m \left(\frac{11mg + 4ma}{13m} \right) \dots\dots(7)$$

from eqⁿ (5) and (7) and (1)

$$\frac{3}{5}(4mg - 3ma) = 12ma - \frac{4}{5} \left[\frac{8m}{13}(2g - 4a) \right]$$

After solving

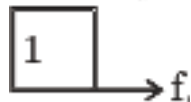
$$a = \frac{220g}{1025}$$

$$\boxed{a = \frac{440m}{205s^2}} \text{ (B)}$$

$$5) kx_{\max} = (m + M) a_{\max}$$

$a_{\max}$ will be when f will be equal to f_0

$$\xrightarrow{\quad} a_{\max}$$



$$f_0 = (0.2)(1g)$$

$$a_{\max} = \frac{(0.2)(1g)}{1} = 2m/s^2$$

6)

Conservation of momentum

$$1 \times 8 + 3 \times 4 = (1 + 3)v \quad \dots (i)$$

$$v = 5$$

Applying work energy theorem

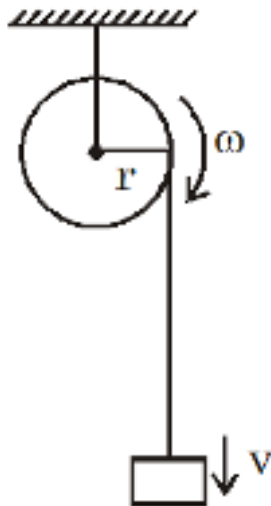
$$W_f = \frac{1}{2} \times 4 \times 5^2 - \frac{1}{2} \times 1 \times 8^2 - \frac{1}{2} \times 3 \times 4^2$$

$$W_f = -6$$

$$9) \frac{1}{2} \left[\frac{m(2R)^2}{3} + m(2R)^2 \right] \omega^2$$

$$= mg \left(2R - 2R \times \frac{1}{2} \right) + mg \left(R - \frac{R}{2} \right)$$

$$\frac{1}{2} \frac{16R^2}{3} \omega^2 = g2R \times \frac{1}{2} + g \frac{R}{2} \frac{16R^2}{3} \omega^2 = \frac{3gR}{2}$$



10)

$$mgh = \frac{1}{2} I \omega^2 + \frac{1}{2} mv^2$$

$$v = \omega r$$

$$mgh = \frac{1}{2} I \omega^2 + \frac{1}{2} m \omega^2 r^2$$

$$\frac{2mgh}{(I + mr^2)} = \omega^2$$

$$11) \frac{Mv^2}{R} = \frac{GM^2}{4R^2}$$

$$\Rightarrow M = \frac{4Rv^2}{G}$$

$$v = \frac{2\pi R}{T}$$

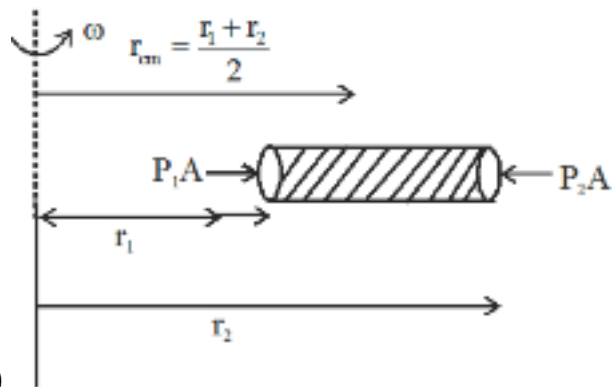
$$R = \frac{vT}{2\pi}$$

$$M = \frac{v^3 T^2}{\pi G}$$

$$12) R_e = \frac{\rho v d}{\eta} ; Q = V \times \frac{\pi d^2}{4}$$

$$= \frac{\rho 4 Q d}{\eta \pi d^2} ; \Rightarrow V = \frac{4 Q}{\pi d^2}$$

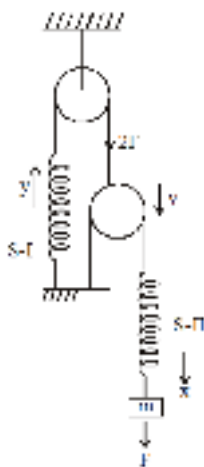
$$R_e = \frac{4 Q \rho}{\pi \eta d}$$



$$13) (P_2 - P_1) A = m \omega^2 r_{CM}$$

$$(P_2 - P_1) A = P_w (r_2 - r_1) A \omega^2 \frac{(r_1 + r_2)}{2}$$

$$\Rightarrow \omega = \sqrt{\frac{2(P_2 - P_1)}{(r_2^2 - r_1^2) \rho_w}}$$



$$14) \text{ Let the block be displaced by } x \text{ and S-I extends by } y$$

$$y = \frac{2F}{2K} = \frac{F}{K}$$

$$\text{S-II extends by } x - 2y$$

$$F = k(x - 2y)$$

$$F = kx - 2k \cdot \frac{F}{K}$$

$$3F = kx$$

$$F = \frac{kx}{3}$$

$$T = 2\pi \sqrt{\frac{3m}{k}}$$

15) Question Explanation:

Use node-antinode conditions and given distances to identify the fundamental shape.

Concept:

Boundary conditions of standing waves.

Solution:

At B (free end) $\rightarrow$ antinode

At C (constrained) $\rightarrow$ node

In option (1), the portion CB is from node to antinode, so

$$CB = \frac{\lambda}{4}$$

Given:

$$CB = 20 \text{ cm} \Rightarrow \frac{\lambda}{4} = 20 \Rightarrow \lambda = 80 \text{ cm}$$

Total length AB = 100 cm, hence

$$AC = 100 - 20 = 80 \text{ cm} = \lambda$$

So between A and C, there is one complete wave, satisfying:

A fixed $\rightarrow$ node

C constrained $\rightarrow$ node

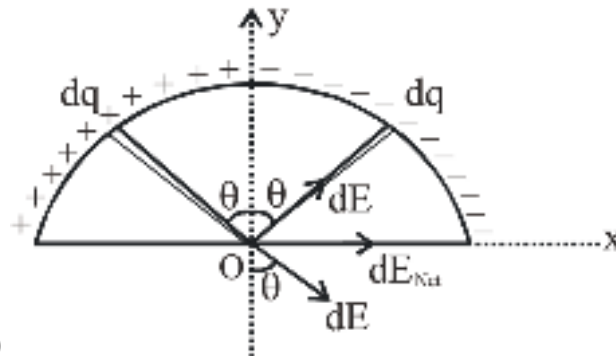
Thus, the shape shown in option (1) satisfies all constraints.

Final Answer: The correct option is (1).

$$\begin{aligned}
 18) \quad \left. \frac{dm}{dt} \right|_{\text{Steam}} &= \frac{1}{16} \left. \frac{dm}{dt} \right|_{\text{ice}} \\
 \left. \frac{dQ}{dt} \right|_{\text{Steam}} &= \frac{T - 100}{\left(\frac{2\ell}{3Ak} \right)} = \left(\frac{dm}{dt} \right)_{\text{steam}} L_v \\
 \left. \frac{dQ}{dt} \right|_{\text{Ice}} &= \frac{T - 0}{\left(\frac{\ell}{3Ak} \right)} = 16 \left(\frac{dm}{dt} \right)_{\text{steam}} L_f \\
 \frac{T - 100}{T} &= \frac{L_v}{16L_f} \\
 \frac{(T - 100)}{2T} &= \frac{540}{16 \times 80} \\
 \frac{T - 100}{T} &= \frac{640}{540} \\
 \frac{T - 100}{2T} &= \frac{8 \times 80}{540}
 \end{aligned}$$

19)

$$\begin{aligned}
 \text{Electric field} &= \frac{2K\lambda}{r} \\
 \Rightarrow \frac{2K\lambda}{r} &= \frac{mv^2}{r} \\
 \sqrt{\frac{2K\lambda}{m}} &= v = (\text{independent of } r.)
 \end{aligned}$$



20)

Net electric field due to dq charge placed symmetrically about y-axis at O

$$\begin{aligned}
 E_{\text{Net}} &= \int dE_{\text{Net}} = \int 2dE \sin \theta \\
 &= \frac{2}{4\pi\epsilon_0 R^2} \int \sin \theta \cdot dq \\
 &= \frac{1}{2\pi\epsilon_0 R^2} \int \sin \theta \left(R d\theta \cdot \frac{Q}{L/2} \right) \\
 &= \frac{Q}{\pi\epsilon_0 R L} \int_0^{\pi/2} \sin \theta d\theta \\
 &= \frac{10^3 \epsilon_0}{(0.2)^2 \times \epsilon_0} \times 1 \quad [pR = L]
 \end{aligned}$$

21)

Question Explanation :

We have to calculate the value of resistance R in the given potentiometer circuit.

Concept :

This question is based on Application of Potentiometer.

Solution :

$$\begin{aligned}
 iR &= \Delta \phi \\
 \left(\frac{E_s}{r+R} \right) R &= \ell_1 \phi \\
 \left(\frac{E_1}{r_1+R} \right) R &= \ell_1 \phi \quad \dots\dots (1)
 \end{aligned}$$

$$\left(\frac{E_2}{r_2+R} \right) R = \ell_2 \phi \quad \dots\dots (2)$$

$$\left(\frac{E_1}{E_2} \right) \left(\frac{r_2+R}{r_1+R} \right) = \frac{\ell_1}{\ell_2}$$

$$\frac{10}{5} \left(\frac{2+R}{1+R} \right) = \frac{30}{10} = 3$$

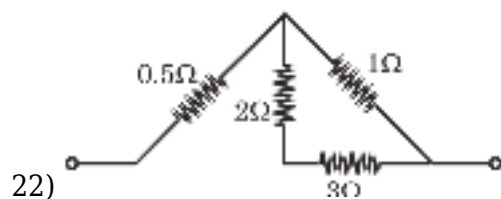
$$2 \left(\frac{2+R}{1+R} \right) = 3$$

$$4 + 2R = 3 + 3R$$

$$R = 1\Omega$$

Hence,

Option (1) is correct : 1Ω



$$R_{eq} = 0.5 + \frac{1 \times 5}{1 + 5} = \frac{1}{2} + \frac{5}{6} = \frac{8}{6} = \frac{4}{3}\Omega$$

23) **Question Explanation:**

Finding wire acceleration in a magnetic field.

Concept:

Magnetic Force on a Curved Current Wire.

Solution:

The magnetic force on a curved wire in a uniform field depends only on the projected length (the straight distance between the start and end points). For this halfellipse, the ends are at $y = b$ and $y = -b$, making the effective length $2b$.

Calculation:

Effective length (L) distance between endpoints $= b + b = 2b$

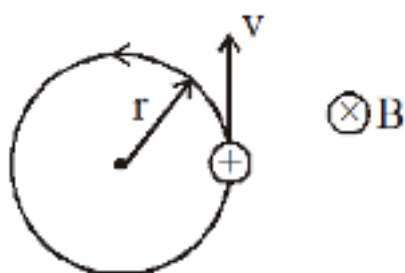
Magnetic Force (F) $= i \cdot L \cdot B = i(2b)B = 2ibB$

Acceleration (a) $= \frac{\text{Force}}{\text{mass}} = \frac{2ibB}{m}$

Final Answer:

Option (4)

24) Pitch $= (\text{Component of } \vec{v} \text{ along } \vec{B}) \left(\frac{2\pi m}{qB} \right)$
 $\Rightarrow P_2 = P_0$



25)

Magnetic moment

$$M = iA$$

$$M = \left(\frac{q}{T} \right) \times \pi r^2 = \frac{q\pi r^2}{\left(\frac{2\pi r}{v} \right)} = \frac{qvr}{2}$$

$$M = \frac{qv}{2} \times \frac{vm}{qB}$$

$$M = \frac{mv^2}{2B}$$

As we can see from the figure, direction of magnetic moment (M) is opposite to magnetic field.

$$\vec{M} = -\frac{mv^2}{2B} \hat{B}$$

$$= -\frac{mv^2}{2B^2} \vec{B}$$

26) Refraction at first surface,

$$\frac{3}{v} - \frac{1}{-9} = \frac{\left(\frac{3}{2} - 1\right)}{+3}$$

$$\frac{3}{2v} + \frac{1}{9} = \frac{1}{6}$$

$$v = 27$$

refraction at second surface, $\frac{1}{v} - \frac{1.5}{24} = 0$

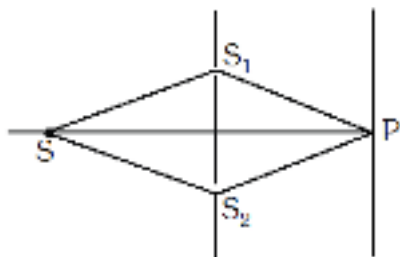
$$v = 16 \text{ m}$$

To the left of C

27) **Explain Question** : We have to choose the correct statements when the source S is moved parallel to the plane of the slits and closer to the upper slit.

Concept : Interference of light (YDSE)

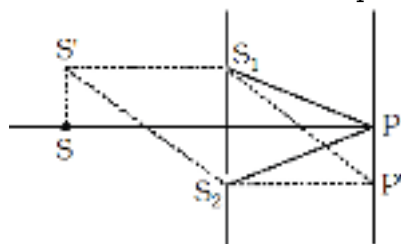
Solution :



Initially

$$S S_1 + S_1 P = S S_2 + S_2 P$$

Now the source is moved parallel to plane



Now $S' S_2 > S' S_1$

□ $S_1 P$ must increase so that path difference remains zero.

Hence the fringe width will remain same but fringe pattern will shift down.

Final Answer : option (4)

28) **Question Explanation**: The question asks to find the higher state radius.

Concept: Bohr's Model of the Hydrogen Atom.

Solution:

$$v \propto \frac{1}{n} \Rightarrow \text{If } v \text{ becomes } \frac{1}{3}, \text{ then } n = 3.$$

$$r \propto n^2 \Rightarrow r_{new} = R \times (3)^2$$

$$r_{new} = 9R$$

Final Answer: Option (4)

$$\lambda = \frac{\ln 2}{T_{\frac{1}{2}}} = \frac{0.693}{20} = 0.03465$$

29)

Alternate solution

$$t = \frac{2.303}{\lambda} \log \left(\frac{N_0}{N} \right)$$

When substance is 33% disintegrated

$$N_1 = \frac{2N_0}{3}$$

$$t_1 = \frac{2.303}{0.03465} \log \left(\frac{100}{67} \right) = 11.6 \text{ min}$$

When 67% disintegrated $N_2 = \frac{N_0}{3}$

$$t_2 = \frac{2.303}{0.03465} \log \left(\frac{100}{33} \right) = 32 \text{ min}$$

$$N_2 = \frac{N_1}{2}$$

$$t_2 - t_1 = 32 - 11.6$$

So, time taken is one half life = 20 min
= 20.4 $\simeq$ 20min

CHEMISTRY

31) (A) Non-Aromatic (B) Aromatic
(C) Aromatic (D) Anti-Aromatic

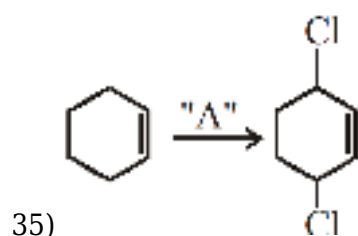
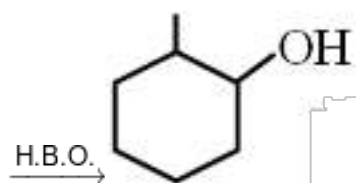
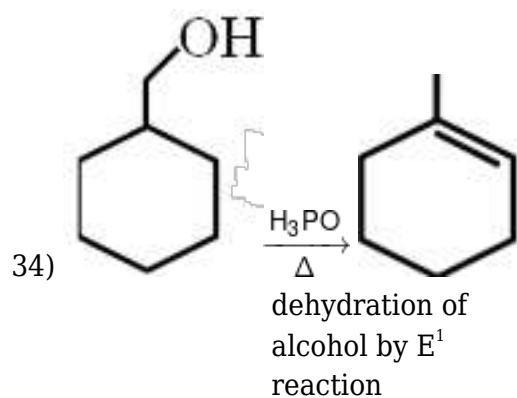
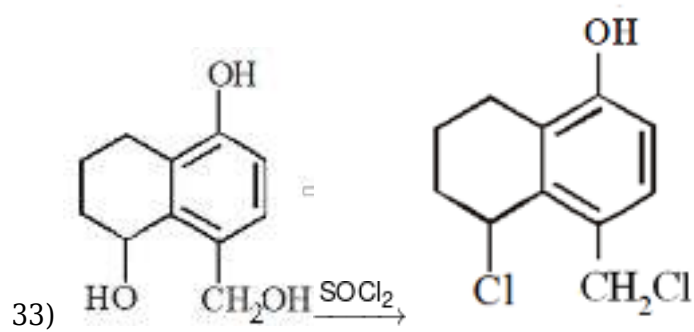
32)

More stable less potential energy.

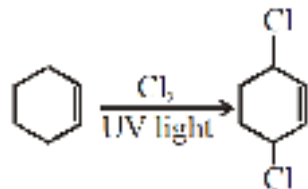
Stability order : I > III > IV > II

So

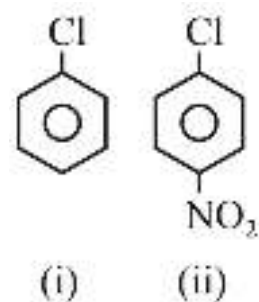
Potential energy : II > IV > III > I

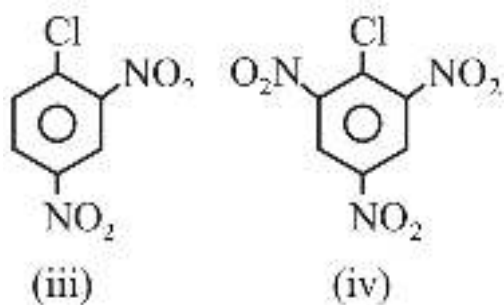


For substitution at allylic position in the given compound, the reagent used is Cl₂/uv light. The reaction is free radical halogenation.



36) For nucleophile substitution in aromatic halides



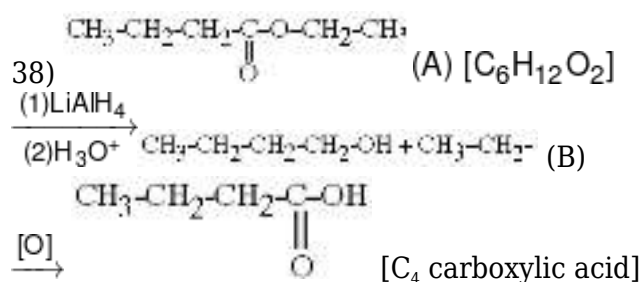
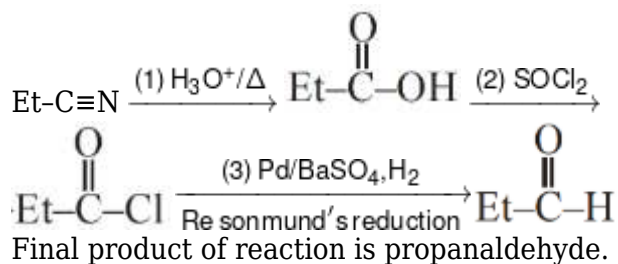


Correct order is :

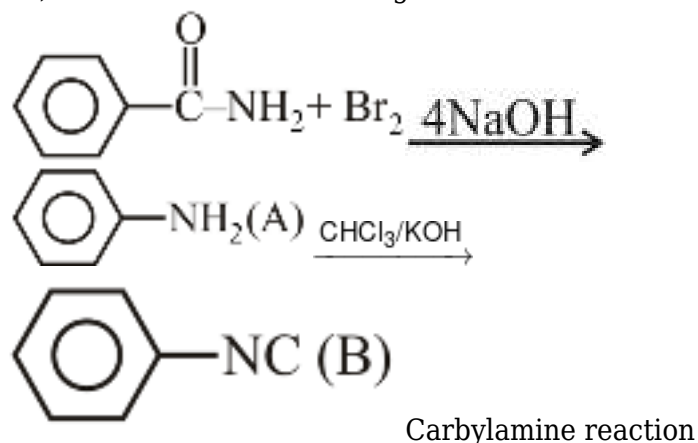
(i) < (ii) < (iii) < (iv)

More No. of NO_2 substituted aromatic halide, increase the rate of nucleophile substitution reaction in aromatic halides.

37)



39) Hoffmann bromamide degradation reaction :



40) Seliwanoff test for ketose and Xanthoprotic test for proteins.

41)

Question Explanation: Calculating minimum molecular weight of the sodium salt of methyl orange.

Concept: Minimum Molecular Weight

Solution: For minimum molecular weight, assume the molecule contains exactly one atom of sodium. Equate the mass of one Na atom (23) to its given percentage.

$$\frac{23}{M} \times 100 = 7$$

$$M = \frac{100}{7} \times 23 \simeq 329$$

Final answer: 329

42) **Question Explanation:**

Which equilibrium favoured by low temperature and low pressure.

Concept:

This question is based on Le-chatelier's principle.

Solution:

Temp. ↓ equilibrium shift forward for exothermic reaction where heat is released

Pressure ↓ equilibrium shift forward when number of gaseous moles increases on product side



Low temperature & low pressure is favoured for forward direction.

Final Answer:

The correct option is (3).

43) **Explain Question :**

Calculate the density of a BCC unit cell with given corner separation.

Concept:

Unit Cell Density

Solution:

In BCC, atoms touch along the body diagonal.

Use the given separation between corner atoms to find the edge length a, then apply the density formula.

Calculation:

$$a - 2r = 67 \text{ pm}; 2r = \frac{\sqrt{3}a}{2}$$

$$a(1 - 0.866) = 67 \Rightarrow a = 500 \text{ pm} = 5 \times 10^{-8} \text{ cm}$$

$$\text{Density} = \frac{Z \times M}{N_A \times a^3} = \frac{2 \times 75}{6 \times 10^{23} \times (5 \times 10^{-8})^3} = 2.00$$

Final Answer: Option (1)

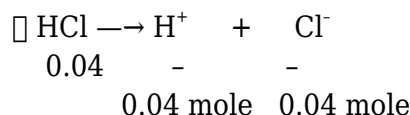
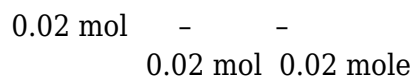
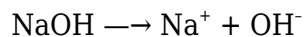
45)

Moles of NaOH = M × Volume in litres

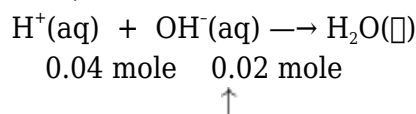
$$= 0.2 \times \frac{100}{1000}$$
$$= 0.02$$

$$\text{Moles of HCl} = 0.4 \times \frac{100}{1000} = 0.04$$

Both HCl & NaOH are strong electrolyte



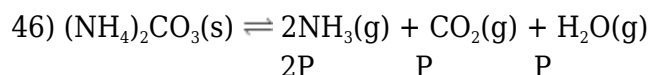
Now, Neutralisation reaction takes place



(Limiting reagent)

When 1 mole OH^- neutralizes with $\text{H}^+ \Rightarrow 57.5 \text{ kJ}$ energy is released

$\square$ 0.02 mole OH^- neutralizes with $\text{H}^+ \Rightarrow (57.5 \times 0.02) \text{ kJ} \Rightarrow 1.15 \text{ kJ}$
 $\Rightarrow 1150 \text{ J}$ energy is released.



$$K_p = (2P)^2 \cdot P \cdot P = 64 \text{ atm}$$

$$P = 2 \text{ atm}$$

$$P_{\text{total}} = 2P + P + P = 8 \text{ atm}$$

47)

Question Explanation: Determine which ion concentrations cause CaF_2 precipitation.

Concept: This question is based on Precipitation Condition (IP vs K_{sp})

Solution:

When equal volumes of two solutions are mixed, the concentration of each ion is immediately halved.

Precipitation occurs when $\text{IP} = [\text{Ca}^{2+}][\text{F}^-]^2 > K_{\text{sp}} = 1.7 \times 10^{-10}$.

$$(1): \text{IP} = \left(\frac{10^{-4}}{2}\right) \left(\frac{10^{-4}}{2}\right)^2 = 1.25 \times 10^{-13} \quad . \text{IP} < K_{\text{sp}} \Rightarrow \text{No. ppt}$$

$$(2): \text{IP} = \left(\frac{10^{-2}}{2}\right) \left(\frac{10^{-3}}{2}\right)^2 = 1.25 \times 10^{-9} \quad . \text{IP} > K_{\text{sp}} \Rightarrow \text{Yes. ppt}$$

$$(3): \text{IP} = \left(\frac{10^{-5}}{2}\right) \left(\frac{10^{-3}}{2}\right)^2 = 1.25 \times 10^{-12} \quad . \text{IP} < K_{\text{sp}} \Rightarrow \text{No. ppt}$$

$$(4): IP = \left(\frac{10^{-3}}{2}\right) \left(\frac{10^{-5}}{2}\right)^2 = 1.25 \times 10^{-14} \quad . IP < K_{sp} = \text{No. ppt}$$

Final Answer: Option (2)

51) Uut (113) : $[Rn]5f^{14}6d^{10}7s^27p^1$

52)

Theory based

53) Froth flotation is used for sulphide ores.

Ethyl xanthate act as froth collector

NaCN act as depressant

54) Colour of Fe^{2+} is observed green and Fe^{3+} is yellow

55) $2Fe^{3+} + H_2S \rightarrow 2Fe^{2+} + S + 2H^+$

BaS passes into solution due to hydrolysis

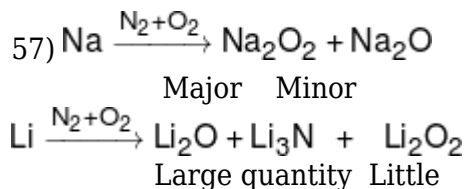
56) **Explain the question:** Identify least soluble fluoride

Concept: Solubility trend of alkali metal halides

Solution:

- A. Solubility of alkali metal fluorides increases down the group as cation size increases, reducing lattice energy.
- B. LiF has the smallest cation, highest lattice energy, and is therefore the least soluble.

Final Answer: Option (1)



58)

Question Explanation: Identifying the pair of hydrated ions that are both pink.

Concept: Color of Hydrated Ions.

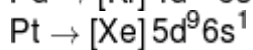
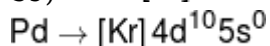
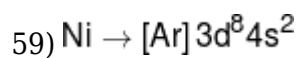
Solution: The characteristic colors of common hydrated 3d-metal ions must be known.

A. $[Mn(H_2O)_6]^{2+}$ is very pale pink.

B. $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$ is pink.

The pair with two pink-colored ions is (Mn, Co).

Final Answer: 2. (Mn^{2+} , Co^{2+}).



60) H_2O_2 is manufactured by Electrolysis of 50% conc. H_2SO_4 using inert electrodes

ENGLISH PROFICIENCY

61) The correct answer is (4)

62) The correct answer is (4)

63) The correct answer is (4)

64) The correct answer is (3)

65) The correct answer is (1)

66) The correct answer is (2)

67) The correct answer is (3)

68) The correct answer is (3)

69) The correct answer is (2)

70) The correct answer is (3)

LOGICAL REASONING

71) The correct answer is (4)

72) The correct answer is (4)

73) The correct answer is (4)

74) The correct answer is (3)

75) The correct answer is (1)

76) The correct answer is (1)

77) The correct answer is (4)

78) The correct answer is (4)

79) The correct answer is (3)

80) The correct answer is (1)

81) The correct answer is (4)

82) The correct answer is (3)

83) The correct answer is (2)

84) The correct answer is (3)

85) The correct answer is (4)

86) The correct answer is (3)

87) The correct answer is (3)

88) The correct answer is (3)

89) The correct answer is (3)

90) The correct answer is (1)

91) **Question Explanation:** Use the condition for a complex number to be purely imaginary.

Concept: This question is based on Purely Imaginary Complex Numbers

Solution:

$$\frac{z - \alpha}{z + \alpha} + \frac{\bar{z} - \alpha}{\bar{z} + \alpha} = 0$$

$$z\bar{z} + z\alpha - \alpha\bar{z} - \alpha^2 + z\bar{z} - z\alpha + \bar{z}\alpha - \alpha^2 = 0$$

$$|z|^2 = \alpha^2, \alpha = \pm 2$$

Final Answer: The correct option is (2).

$$92) \left(\frac{-1 + i\sqrt{3}}{1 - i} \right)^{30} = \left(\frac{2\omega}{1 - i} \right)^{30}$$

$$= \frac{2^{30} \cdot \omega^{30}}{(1 - i)^{15}}$$

$$= \frac{2^{30} \cdot 1}{(1 + i^2 - 2i)^{15}}$$

$$= \frac{2^{30}}{-2^{15} \cdot i^{15}}$$

$$= -2^{15}i$$

93) **Question Explanation:**

In this question, we are given a quadratic equation and define a sequence as the sum of the n^{th} power of its roots. It is also given a linear relation involving terms A_{n+2} , A_{n+1} and A_n with unknown coefficients μ and ν . We have to find the sum $(\mu + \nu)$.

Concept:

This question is based on Newton's formula

If α, β are the roots of $ax^2 + bx + c = 0$ and $T_n = \alpha^n + \beta^n$ then we can replace

x^2 as T_{n+2}

x as T_{n+1}

(1) as T_n

In our quadratic equation.

$$aT_{n+2} + bT_{n+1} + cT_n = 0$$

Solution:

Given that α and β are the roots of equation $x^2 - 5x - 3 = 0$ and $A_n = \alpha^n + \beta^n$ & $A_{n+2} + \mu A_{n+1} + \nu A_n = 0 \dots (1)$

By using Newton's formula,

$$x^2 \rightarrow T_{n+2}$$

$$x \rightarrow T_{n+1}$$

$$(1) \rightarrow T_n$$

$$A_{n+2} - 5A_{n+1} - 3A_n = 0 \dots (2)$$

Compare eq.(1) with eq.(2)

We got $\mu = -5$ and $\nu = -3$

So, $\mu + v = -8$

Final Answer:

The correct option is (4).

$$94) \Rightarrow \begin{vmatrix} 2 & 1 \\ b & -1 \end{vmatrix}^2 = \begin{vmatrix} 2 & b \\ b & 1 \end{vmatrix} \begin{vmatrix} b & 1 \\ 1 & -1 \end{vmatrix}$$

$$(b + 2)^2 = (2 - b^2)(-b - 1) = (b^2 - 2)(b + 1)$$

$$b^2 + 4 + 4b = b^3 + b^2 - 2b - 2 \Rightarrow b^3 - 6b = 6$$

95) $\Rightarrow$ a, G_1, G_2, b are in G.P.

$$G_1^2 = aG_2 \text{ \& } G_2^2 = G_1b$$

$$\frac{G_1^2}{G_2} + \frac{G_2^2}{G_1} = a + b = 2 \left(\frac{a+b}{2} \right) = A_1 + A_2$$

96)

Question Explanation: Finding numbers based on the sum and count of their divisors.

Concept: Properties of Divisors and Prime Factorization.

Solution:

Let number be N number has four divisors

$\Rightarrow N = p_1 \times p_2$ (where p_1 & p_2 are prime numbers)

or number $= p_1^3$

If $N = p_1 \times p_2$

$\Rightarrow p_1 + p_2 = 30$

possible pairs are (7, 23), (11, 19), (13, 17)

If $N = p_1^3$

$\Rightarrow p_1 + p_1^2 = 30$

Pairs of primes summing to 30: (7, 23), (11, 19), (13, 17).

Numbers $= 7 \times 23, 11 \times 19, 13 \times 17$ (3 values).

Total numbers $= 1 + 3 = 4$.

Final Answer: 4

97) At least two digits are identical i.e. atleast one digit is repeated

$$\underline{5} \quad \underline{5} \quad \underline{5} \quad \underline{5} \quad \underline{5} \quad \underline{4} \quad \underline{3} \quad \underline{2}$$

$$\square \leftarrow \text{No. of ways} \rightarrow - \leftarrow \text{No. of ways} \rightarrow = 505$$

(Repetition is allowed - Repetition is not allowed)

98)

Let two successive terms in the expansion of $(1 + x)^{24}$ are T_r and T_{r+1} .

$$T_r = {}^{24}C_{r-1} x^{r-1} \text{ (coefficient} = {}^{24}C_{r-1})$$

$$T_{r+1} = {}^{24}C_r x^r \text{ (coefficient} = {}^{24}C_r)$$

$$\text{given, } \frac{T_r}{T_{r+1}} = \frac{1}{4} \Rightarrow \frac{{}^{24}C_{r-1}}{{}^{24}C_r} = \frac{1}{4}$$

$$\Rightarrow \frac{r}{24-r+1} = \frac{1}{4} \Rightarrow r = 5$$

So, successive terms are 5th and 6th.

Final Answer: option (3)

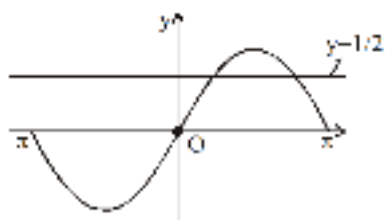
99)

$$M^2 = I - M, M^3 = M(I - M) = M - M^2 = 2M - I$$

$$M^4 = M^3 M = 2I - 3M$$

$$\square n = 4$$

100) Direct open we get $\Rightarrow \sin x = \frac{1}{2}$



Number of solution in $(-\pi, \pi)$ is 2

101) **Question Explanation:** Find the constant term a_0 in the trigonometric series expansion of a determinant.

Concept: Expansion of a Determinant; Constant Term of a Polynomial.

Solution: The expansion is $\Delta(x) = a_0 + a_1 \sin x + a_2 \sin^2 x + \dots$. The constant term a_0 is the value of the determinant when $\sin x = 0$.

102) Since $x \nmid x$, therefore R is not reflexive.

Also $x < y$ does not imply that $y < x$, so R is not symmetric.

Let xRy and yRz . Then $x < y$ and $y < z \Rightarrow x < z$ i.e., xRz . Hence R is transitive.

103) We know that $p \wedge q$ is true only when both p and q are true so option (1) is not correct

we know that $p \rightarrow q$ is false only when p is true and q is false so option (2) is not correct

we know that $p \leftrightarrow q$ is true only when either p and q are both true or both are false

so option (3) is not correct

we know that $\sim(p \vee q)$ is true only when $(p \vee q)$ is false

i.e. p and q both are false

104)

use the result

$$\cot \theta - \tan \theta = 2 \cot 2\theta$$

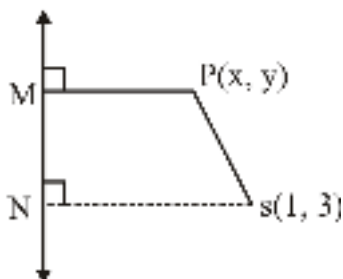
$$105) \cos 2\theta + 2 = k^2 - \cos 2\theta$$

$$2\cos 2\theta = k^2 - 2$$

$$\square k^2 - 2 \in [-2, 2]$$

$$k^2 \in [0, 4] \Rightarrow k \in [-2, 2]$$

$$106) 12 - 4\pi + 8\pi - 25 + 50 - 16\pi + 35 - 11\pi = 72 - 23\pi$$



$$107) x + y - 1 = 0$$

$$(x-1)^2 + (y-3)^2 = \left(\frac{x+y-1}{\sqrt{2}}\right)^2$$

$$|SN| = 2a$$

$$\Rightarrow \left| \frac{1+3-1}{\sqrt{2}} \right| = 2a$$

$$\Rightarrow 2a = \frac{3}{\sqrt{2}}$$

$$\Rightarrow LL' = 4a = \frac{6}{\sqrt{2}} = 3\sqrt{2}$$

$$108) x = 3(\cos t + \sin t) \text{ and } y = 4(\cos t - \sin t)$$

$$\frac{x}{3} = \cos t + \sin t \text{ and } \frac{y}{4} = \cos t - \sin t;$$

$$\frac{x^2}{9} + \frac{y^2}{16} = 2 \text{ ellipse}$$

109)

$$\text{Directrices} \Rightarrow \pm \frac{a}{e}$$

$$\text{foci} \Rightarrow \pm ae$$

$$\frac{2a}{e} = 3 \times 2ae$$

$$e^2 = \frac{1}{3}$$

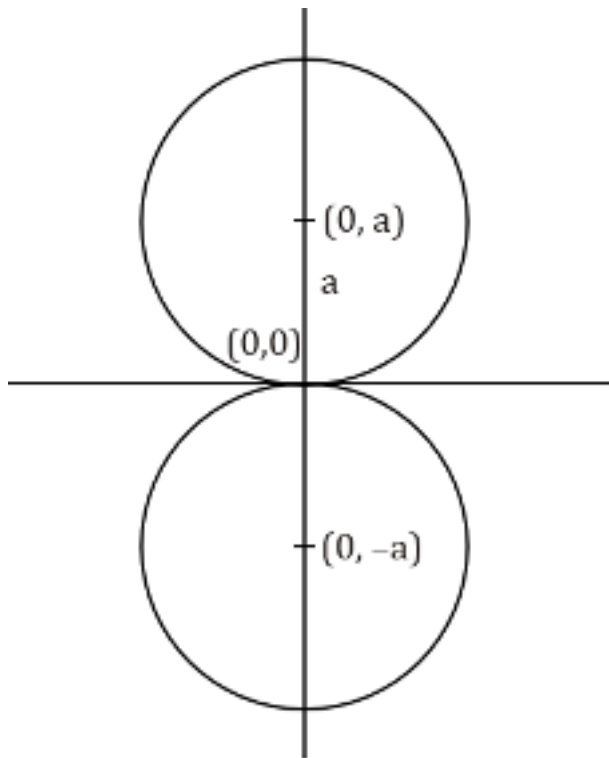
$$e = \frac{1}{\sqrt{3}}$$

Option (C) is correct

110) **Question Explanation:** Find equation circle with radius 'a' touches x-axis at origin.

Concept: Based on definition of circle.

Solution:



Case-1

Radius = a, centre (0, a)

$$(x - 0)^2 + (y - a)^2 = a^2$$

$$x^2 + y^2 - 2ay = 0$$

Case-2

Radius = a, centre (0, -a)

$$(x - 0)^2 + (y + a)^2 = a^2$$

$$x^2 + y^2 + 2ay = 0$$

Final Answer: $x^2 + y^2 \pm 2ya = 0$

111) Slope of AB = $-\frac{1}{2}$

Slope of required line = 2

equation of required line :

$$y - 2 = 2(x - 1)$$

$$y = 2x$$

112) Let $\frac{x-1}{k} = \frac{y-2}{2} = \frac{z-3}{3} = r$

$\Rightarrow (kr + 1, 2r + 2, 3r + 3)$ must be a point on line 2.

i.e. $kr + 1 = 3r + 2$ & $2r + 1 = 3r + 3$

$$\Rightarrow r = -2, k = -5$$

113) Equation of line passing through (5, 1, a) and (3, b, 1) is

$$\frac{x-5}{2} = \frac{y-1}{1-b} = \frac{z-a}{a-1} = \lambda$$

If line crosses yz - plane i.e., $x = 0$

$$x = 2\lambda + 5 = 0$$

$$\Rightarrow \lambda = -\frac{5}{2},$$

$$\text{Since, } \lambda = l(1 - b) + 1 = \frac{17}{2}$$

$$-\frac{5}{2}(1 - b) + 1 = \frac{17}{2}$$

$$b = 4$$

$$\text{Also, } z = \lambda(a - 1) + a = -\frac{13}{2}$$

$$\Rightarrow a = 6$$

$$114) \text{ Line } \frac{x-2}{3} = \frac{y-1}{-5} = \frac{z+2}{2} \quad \dots (1)$$

$$\text{Plane } x + 3y - az + b = 0 \quad \dots (2)$$

Point $(2, 1, -2)$ put in (2)

$$2 + 3 + 2a + b = 0$$

$$\Rightarrow 2\alpha + \beta = -5$$

$$\text{Now } a_1a_2 + b_1b_2 + c_1c_2 = 0$$

$$3 - 15 - 2\alpha = 0$$

$$-12 - 2\alpha = 0$$

$$\alpha = -6$$

$$-12 + \beta = -5 \Rightarrow \beta = 7$$

$$\alpha = -6, \beta = 7$$

116) Explain Question:

Simplifying a scalar triple product expression involving vector sums.

Concept:

Scalar triple product property.

Solution:

$$\Rightarrow \vec{a} \cdot \{(\vec{b} + \vec{c}) \times (\vec{a} + \vec{b} + \vec{c})\}$$

$$\Rightarrow \vec{a} \cdot \{\vec{b} \times \vec{a} + \vec{b} \times \vec{b} + \vec{b} \times \vec{c} + \vec{c} \times \vec{a} + \vec{c} \times \vec{b} + \vec{c} \times \vec{c}\}$$

$$\Rightarrow \vec{a} \cdot \{\vec{b} \times \vec{a} + 0 + \vec{b} \times \vec{c} + \vec{c} \times \vec{a} + \vec{c} \times \vec{b} + 0\}$$

$$\Rightarrow \vec{a} \cdot (\vec{b} \times \vec{a}) + \vec{a} \cdot (\vec{c} \times \vec{a})$$

$$\Rightarrow 0 + 0$$

$$\Rightarrow 0$$

Final Answer: Option(1)

$$117) 10 = \frac{7 + 10 + 11 + 15 + a + b}{6}$$

$$\Rightarrow a + b = 17 \quad \dots (i)$$

$$\frac{20}{3} = \frac{7^2 + 10^2 + 11^2 + 15^2 + a^2 + b^2}{6} - 10^2$$

$$a^2 + b^2 = 145 \quad \dots(ii)$$

Solve (i) and (ii) $a = 9, b = 8$ or $a = 8, b = 9$

$$|a - b| = 1$$

118)

A : Happy hour appears again

B_1 : both H are removed

B_2 : both P are removed

B_3 : two different letters are removed

$$\begin{aligned} P(A) &= \sum_{r=1}^3 P(B_r) P\left(\frac{A}{B_r}\right) \\ &= \frac{1}{{}^9C_2} \cdot 1 + \frac{1}{{}^9C_2} \cdot 1 + \left(1 - \frac{2}{{}^9C_2}\right) \frac{1}{2} \\ p &= \frac{19}{36} \end{aligned}$$

$$119) \frac{dy}{dx} = 1 + \frac{1}{x^2}$$

$$\Rightarrow dy = \left(1 + \frac{1}{x^2}\right) dx$$

$$\Rightarrow y = x - \frac{1}{x} + c \Rightarrow c = 0$$

$$y = x - \frac{1}{x} \text{ at } x = -3, y = -3 + \frac{1}{3}, y = \frac{-8}{3}$$

$$\begin{aligned} 120) & - \int \frac{e^{-x} \left(-\frac{1}{x}\right) - (\ln x) e^{-x}}{(\ln x)^2} dx \\ &= - \int d\left(\frac{e^{-x}}{\ln x}\right) = -\frac{1}{e^x \ln x} + C \end{aligned}$$

$$\begin{aligned} 121) & \int \frac{x^{-2016} dx}{(1 + x^{-2015})^{\frac{2014}{2015}}} = -\left(1 + x^{-2015}\right)^{\frac{1}{2015}} + C \\ &= \frac{a}{b} = 1 \end{aligned}$$

122)

Put $(x^8 + 2x^4) = t$;

$$\Rightarrow \int_0^2 \frac{x^4 + 1}{(x^4 + 2)^{\frac{3}{4}}} dx = \sqrt{3\sqrt{2}}$$

$$123) \int_{1/3}^{\frac{1000}{3}} dx = 333$$

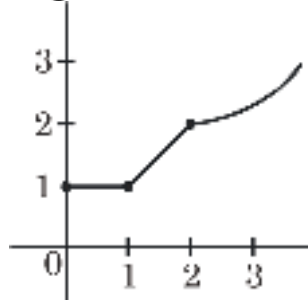
$$124) y = \begin{cases} \{x\}^{[x]} + [x], & \\ 1 & x \in [0, 1) \\ x & x \in [1, 2) \\ (x-2)^2 + 2 & x \in [2, 3) \\ 3 & x = 3 \end{cases}$$

$$A = 1 + \frac{3}{2} + \int_2^3 ((x-2)^2 + 2) dx$$

$$A = \frac{5}{2} + \left(\frac{(x-2)^3}{3} + 2x \right)_2^3$$

$$A = \frac{5}{2} + \left(\frac{1}{3} + 6 \right) - 4$$

$$= \frac{29}{6}$$



$$125) \lim_{x \rightarrow 0} (\cos x)^{\frac{\cos x}{\sin^2 x}} = e^{\lim_{x \rightarrow 0} \frac{(\cos x - 1)(\cos x)}{\sin^2 x}} = e^{-\frac{1}{2}}$$

$$126) f(x) = \begin{cases} ax + bx^2 & ; x < 1 \\ 4ax - 2b + 1 & ; x \geq 1 \end{cases}$$

$$f(1^-) = f(1^+) = f(1)$$

$$\Rightarrow a + b = 4a - 2b + 1$$

$$\Rightarrow 3a - 3b = -1 \quad \dots(1)$$

$$\Rightarrow f'(x) = \begin{cases} a + 2bx & ; x < 1 \\ 4a & ; x \geq 1 \end{cases}$$

$$\Rightarrow f'(1^-) = f'(1^+) \Rightarrow a + 2b = 4a$$

$$\Rightarrow 3a = 2b \quad \dots(2)$$

$$\text{from (1) \& (2), } a = \frac{2}{3}, b = 1$$

$$127) f(x) = \frac{x^2 - 3x - 18}{x^2 - 4x - 12} = \frac{(x-6)(x+3)}{(x-6)(x+2)} = \frac{x+3}{x+2} \dots(1) \quad (x \neq 6)$$

□ Range of $f(x) = \mathbb{R} - \{1\}$ but if $x = 6$

then (1) $\Rightarrow f(6) = \frac{9}{8}$

□ Range = $\mathbb{R} - \left\{1, \frac{9}{8}\right\}$

□ sum = $1 + \frac{9}{8} = \frac{17}{8}$

128) $I = \int_0^{\infty} f\left(x + \frac{1}{x}\right) \frac{\ln x}{x} dx$

Substitute $x = \frac{1}{t}$

$\Rightarrow dx = -\frac{1}{t^2} dt$

$I = \int_0^{\infty} f\left(t + \frac{1}{t}\right) \frac{\ln \frac{1}{t}}{\frac{1}{t}} \left(-\frac{1}{t^2}\right) dt$

$= -\int_{\infty}^0 f\left(t + \frac{1}{t}\right) \frac{\ln t}{t} dt$

$I = -I$

$2I = 0$

129) □ $2 \sin^2 x = 1 - \cos 2x$

and $2 \cos^2 x = 1 + \cos 2x$

also $e^{2x} (C_4 + C_5 e^{6x}) = C \cdot e^{2x}$

Hence only three independent terms

130) Ans. (2)

$\vec{c} = \lambda (\vec{a} \times (\vec{a} \times \vec{b}))$

$\vec{c} = \lambda ((\vec{a} \cdot \vec{b}) \vec{a} - (\vec{a} \cdot \vec{a}) \vec{b}) = \lambda (2\vec{a} - 6\vec{b})$

$\Rightarrow \vec{c} = -2\lambda (\hat{i} + 2\hat{j} + 4\hat{k})$

$\vec{c} \cdot \hat{j} > 0 \Rightarrow \lambda < 0$

$|\vec{c}| = 1 \Rightarrow \lambda = -\frac{1}{2\sqrt{21}}$

$\vec{c} = \frac{1}{\sqrt{21}} (\hat{i} + 2\hat{j} + 4\hat{k})$